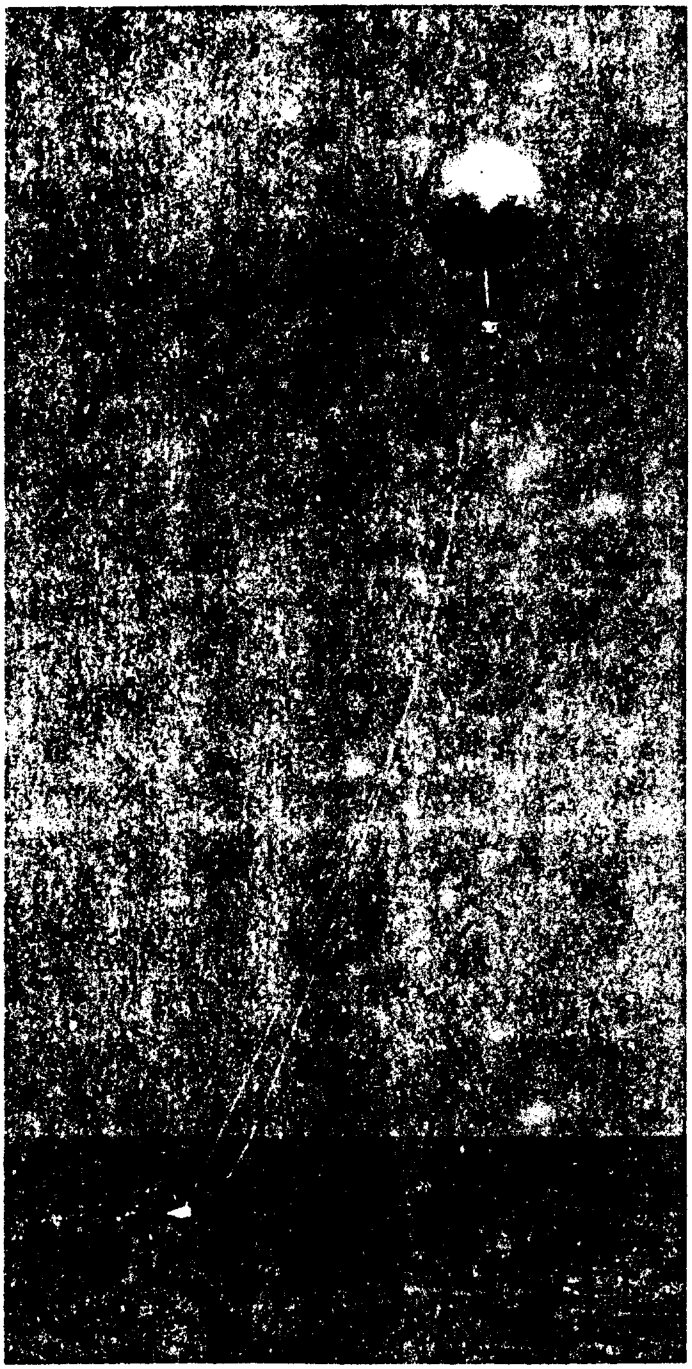
AEROSPACE REPORT NO.
ATR-78(7708-01)-1

ATMOSAT-7 FLIGHT REPORT



The Aerospace Corporation
2350 East El Segundo Boulevard
El Segundo, California

Aerospace Report No.
ATR-78(7708-01)-1

ATMOSAT - 7
Flight Report

January 1978

THE AEROSPACE CORPORATION
2350 E. El Segundo Blvd.
El Segundo, California 90245

Report No.
ATR-78(7708-01)-1

ATMOSAT - 7
Flight Report

Prepared

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I. INTRODUCTION

During October 1977, the City of Long Beach was preparing an Environmental Impact Report (EIR) regarding a planned facility for off-loading crude oil being brought by supertankers from the pipeline terminus at Valdez, Alaska. An important issue to be evaluated in the EIR was the effect of tanker emissions on the air quality of the South Coast Air Basin. The City of Long Beach contracted with The Aerospace Corporation (developer and owner of the ATMOSAT system) to organize and conduct a ballon flight to trace the direction of the air mass originating in the Santa Barbara Channel shipping lanes about ten miles south of Point Conception and to follow that air mass to determine if it moves on shore anywhere in the South Coast Air Basin.

Several meetings were conducted during the week of September 26 to discuss the experimental requirements and the flight plan. As a result of those meetings a protocol was drafted by the South Coast Air Quality Management District (SCAQMD). The protocol can be found in Appendix A.

Flight seven of the ATMOSAT "America" started on October 10, 1977 and concluded on October 11, 1977. This flight was made by The Aerospace Corporation under contract to the Port of Long Beach, with the scientific and operational support of the SCAQMD and the U.S. Coast Guard.

The balloon (Figure 1) moved southeastward along the shipping lane at about seven knots for the first hours of the flight, then stagnated overnight (Figure 2), finally arriving on the beach at Oxnard approximately 26 hours after launch. Flight altitude (Figure 3) was maintained at 200 to 250 feet, typical of the height of tanker emission plumes. The resulting analysis by the SCAQMD of flight data (see Section VII), concurrent meteorological measurements, and historical wind statistics suggest that such a result (in which the air mass does not move directly from the shipping lane into the South Coast Air Basin) would be found most of the time.

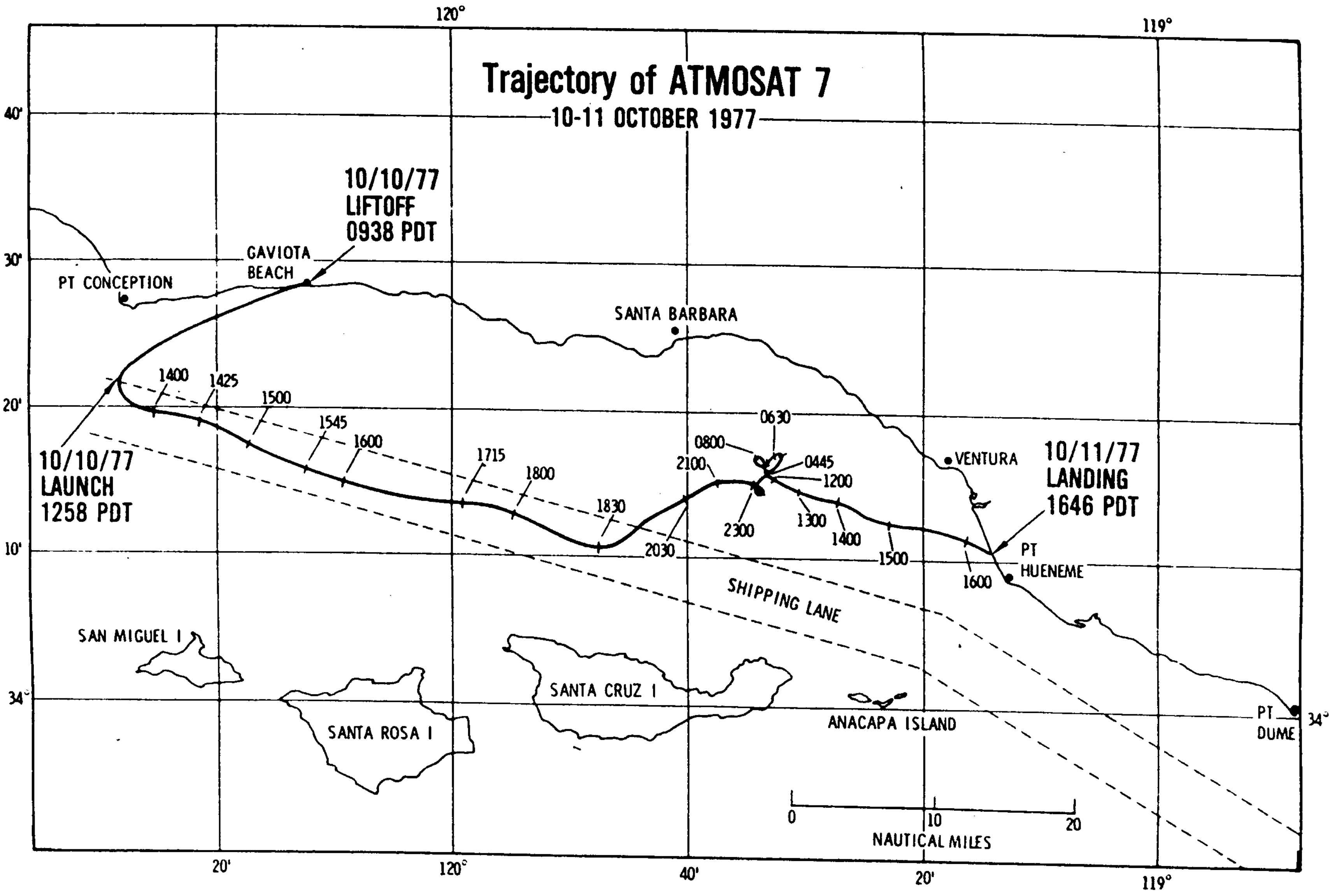

Figure 1. ATMOSAT-7 Flight Trajectory

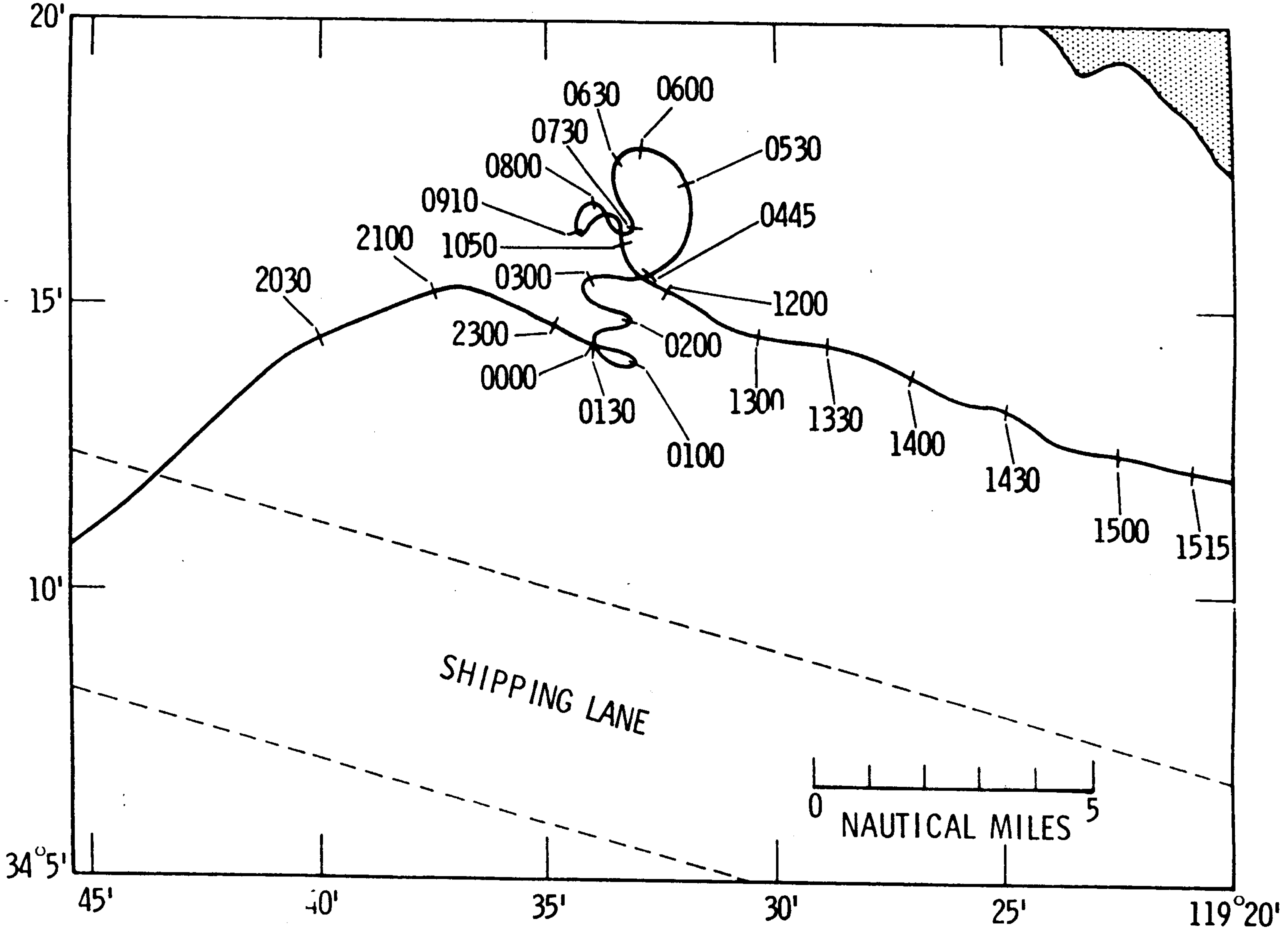

Figure 2. Enlargement of Flight Trajectory During Evening and Early Morning

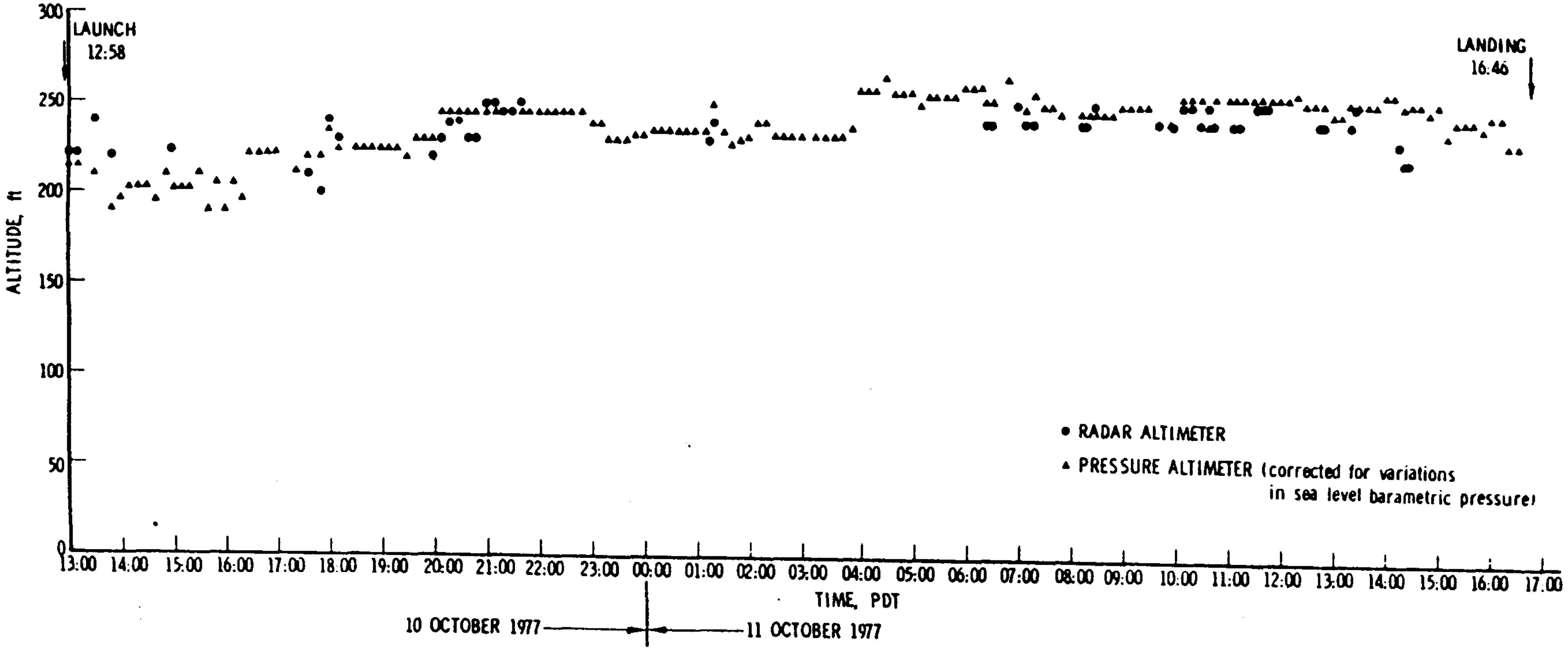

Figure 3. Altitude Profile

II. FLIGHT REQUIREMENTS

The requirements for this flight were: the balloon had to be launched at sea from a preselected point 10 miles south of Point Conception in the shipping lanes, the flight had to last at least 24 hours (or until the air mass being monitored came on shore), and all preparations had to be completed within two weeks.

In order to launch the balloon from a position off-shore, one of two methods had to be employed. The uninflated balloon and a helium trailer containing some 20,000 cubic feet of gas could be ship-carried to the launch site. Once on station, the balloon would be inflated and weighed off on the ship, then released. A second method would involve inflation of the balloon on shore, then towing it to sea using a much smaller ship and releasing it upon arrival at the launch site. It was clear that the first option would require a large and costly vessel and more significantly would require operational procedures that could not be perfected in the short time available between the initial request for the mission and the expected flight date. As the ATMOSAT program had already acquired considerable experience in the inflation of the balloon at remote sites on land, the second option appeared preferable. The decision was made to inflate the balloon on shore and then tow it to the launch site.

Fortunately, the ATMOSAT project recently came into possession of a rare edition of one of the great classics of lighter-than-air literature, "La Triomphe de la Navigation Aerienne," published in Paris in 1911 by Count Henry de la Vaulx. This remarkable book includes an extensive chapter on aero-marine operations similar to those that were under study for this mission. Some 50 pages of text, drawings, and photographs were dedicated to the problems of balloon operations over the sea, including a detailed discussion of several lengthy flights made by the de la Vaulx group in the years 1901 to 1904. Study of these flights convinced the ATMOSAT team that the towing method was feasible. Examination of the diagrams and photographs showed the hardware configuration used by de la Vaulx. As there was no time for preliminary field testing, the needed hardware was procured to match as closely as possible the equipment used in those early flights over the Mediterranean, and procedures were written that paralleled those explained in de la Vaulx's text. A number of photographs from the 1911 report are included in this report in order to show the two systems (see Figures 4 through 8). It will be noted that not only are the configurations similar, though separated by some 75 years of technological progress, but the resulting inflight performances are very much alike. The success of ATMOSAT-7 is entirely due to the pioneering work done by the de la Vaulx expeditions, and to the generosity of Professor J. E. Blamont of the Service d'Aeronomie (Paris, France) who provided the project with one of the few extant copies of this invaluable treatise.

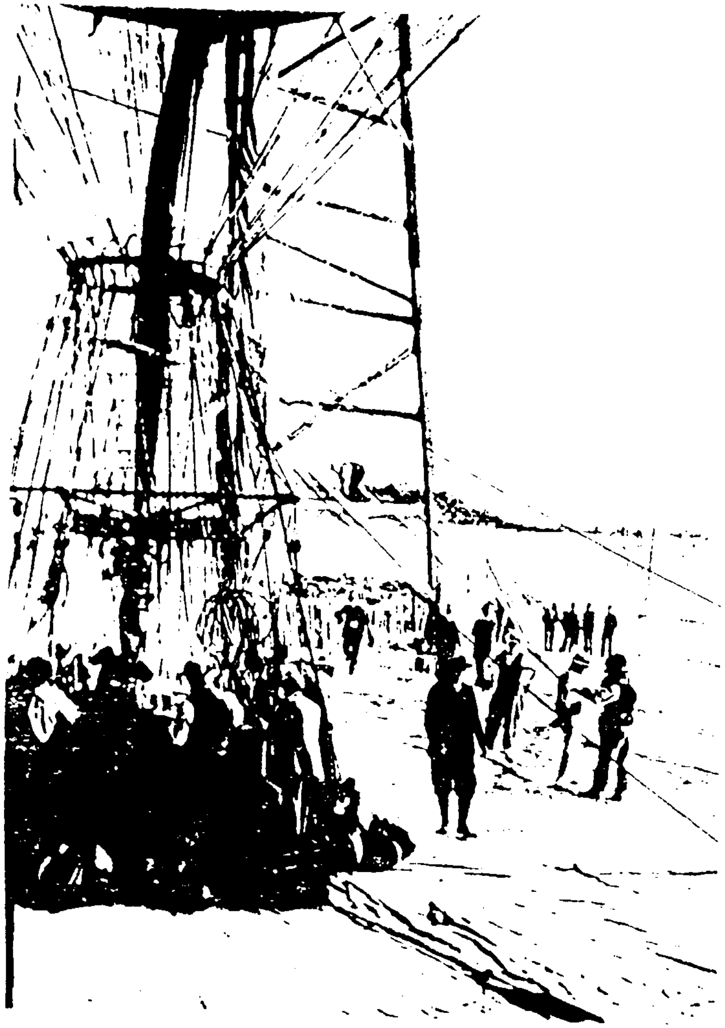

Figure 4a. The balloon "Le MÉDITERRANÉEN" before launch at the beach of Sablettes near Toulon, October 12, 1901. Count de la Vaulx, on the right, oversees the preparations.

Figure 4b. The balloon "AMERICA" before launch at the beach of Gaviota near Santa Barbara, October 10, 1977. Dr. Tom Heinsheimer, on the left, oversees the preparations.

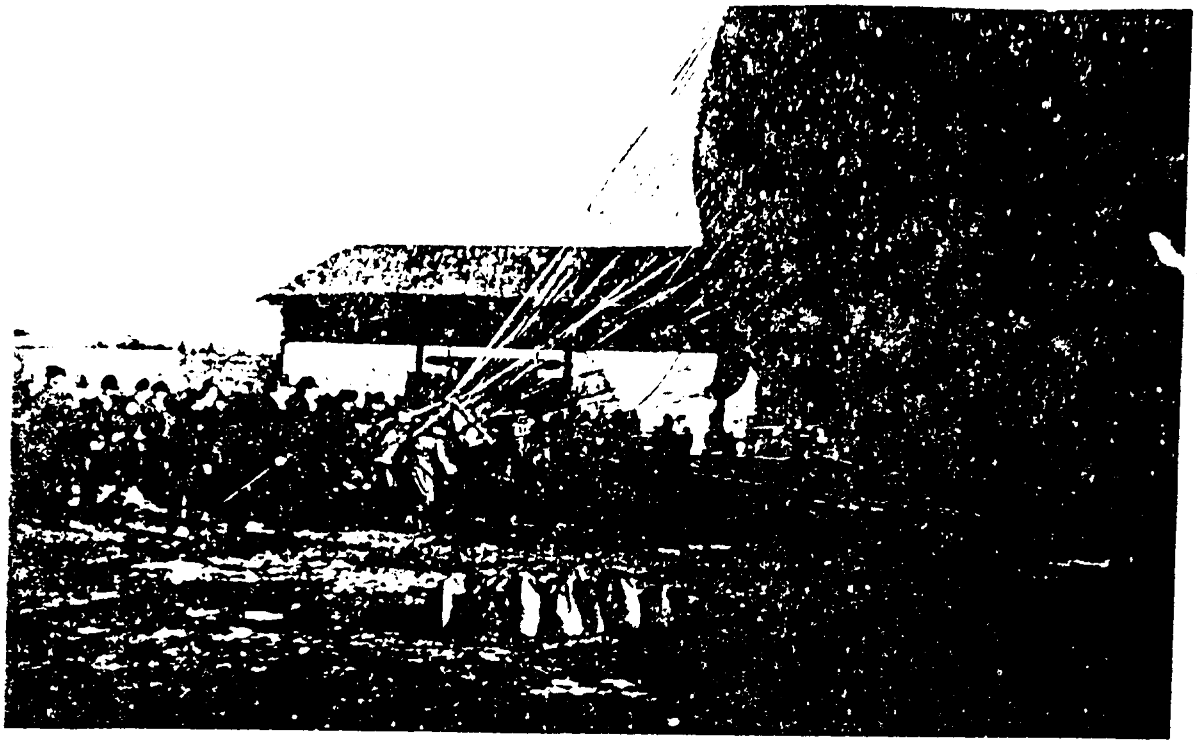

Figure 5a. A gust of wind during the inflation of the "DJINN" at St. Cloud, September 26, 1903.

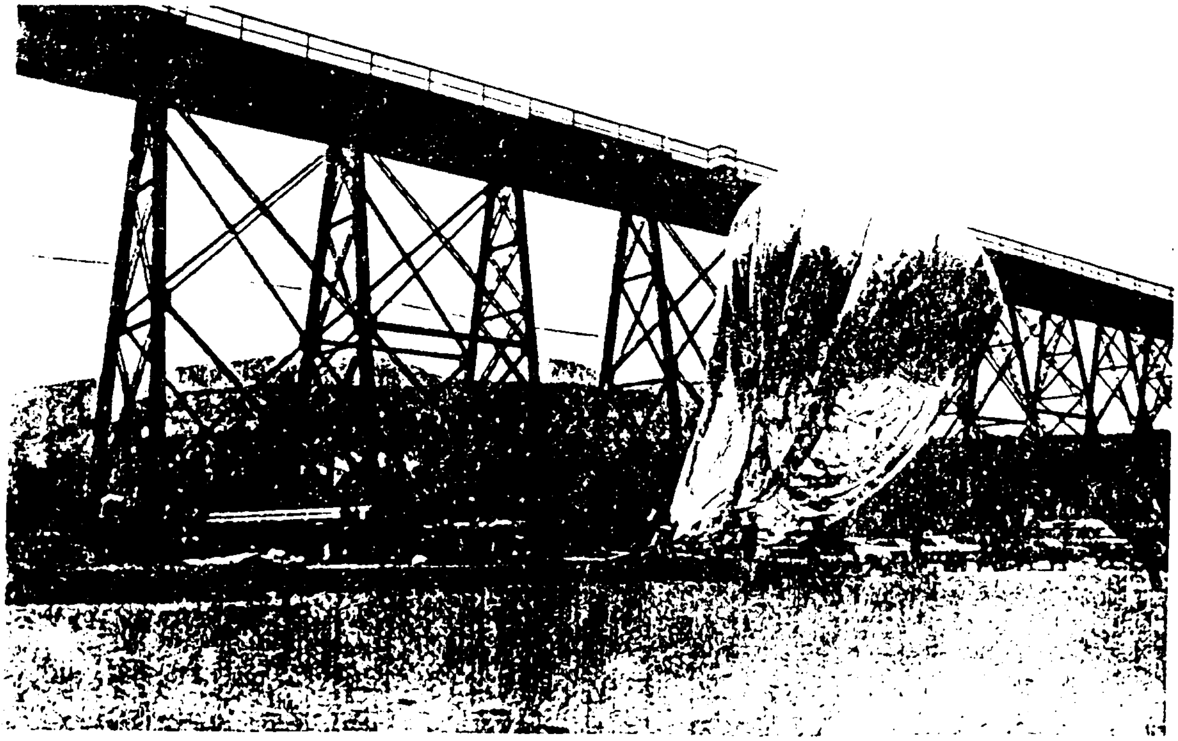

Figure 5b. A gust of wind during the inflation of the "AMERICA" at Gaviota, October 10, 1977.

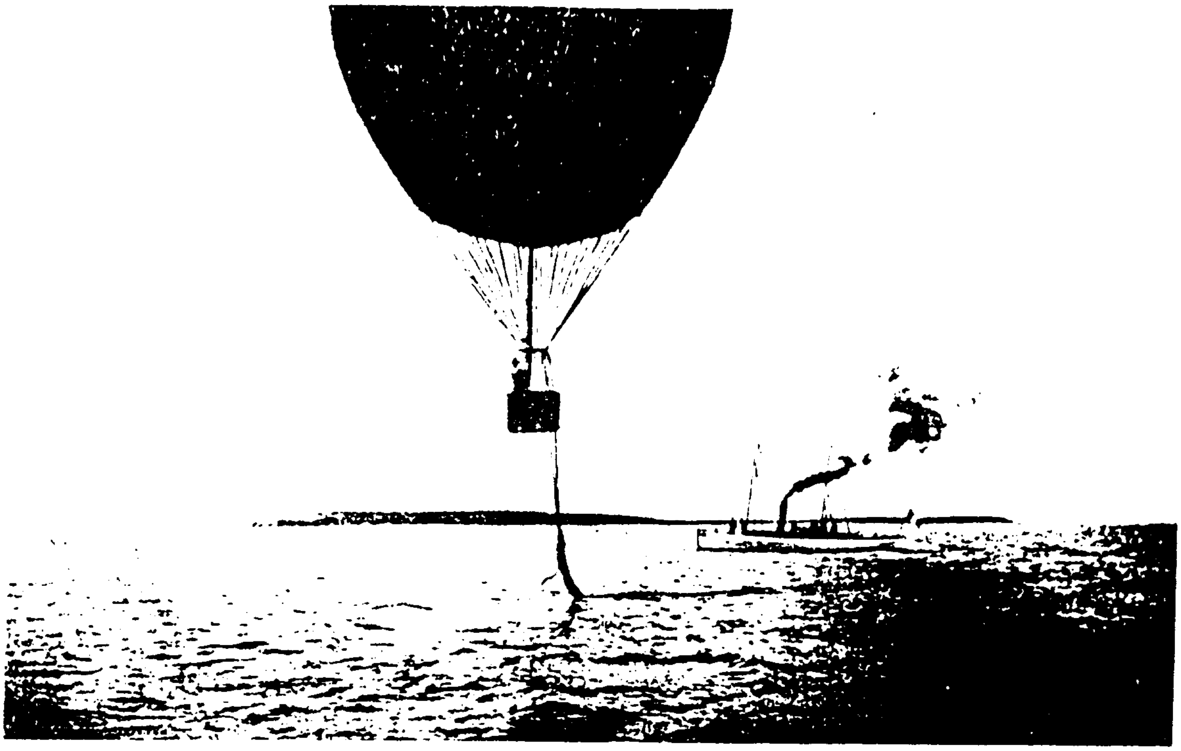

Figure 6a. The "EILATI" on its stabilizer near Cannes with the French naval frigate Dauphin in attendance, March 18, 1904.

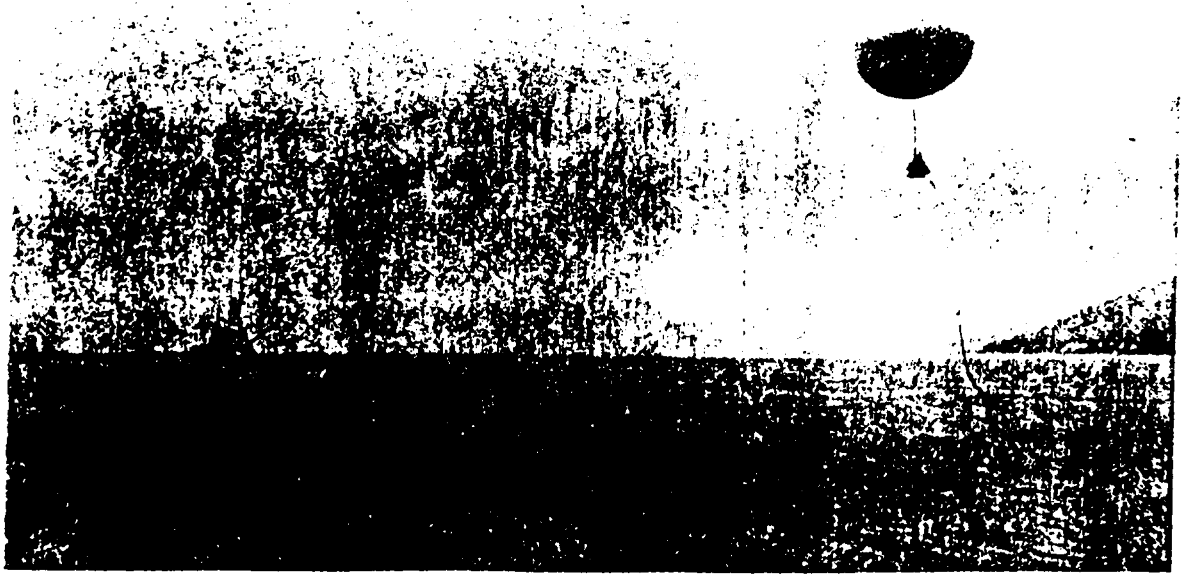

Figure 6b. The "AMERICA" on its stabilizer near Gaviota with the U.S. Coast Guard cutter Point Judith in attendance, October 10, 1977.

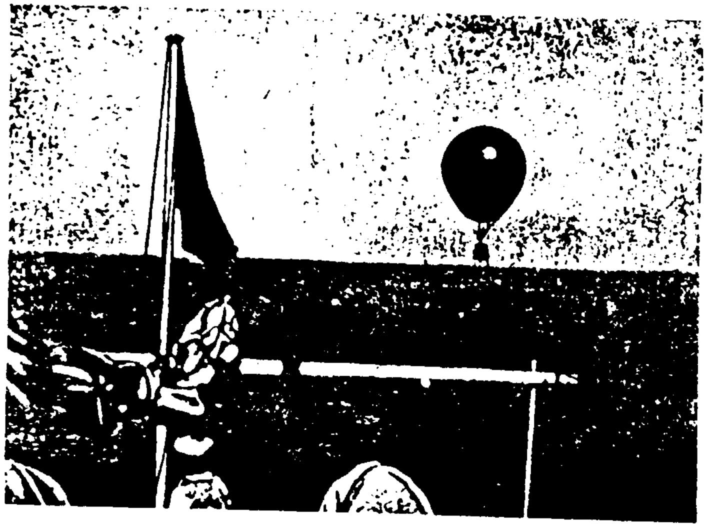

Figure 7a. The balloon "MÉDITERRANÉEN II" at sea, photo taken from the destroyer Epée, September 23, 1902.

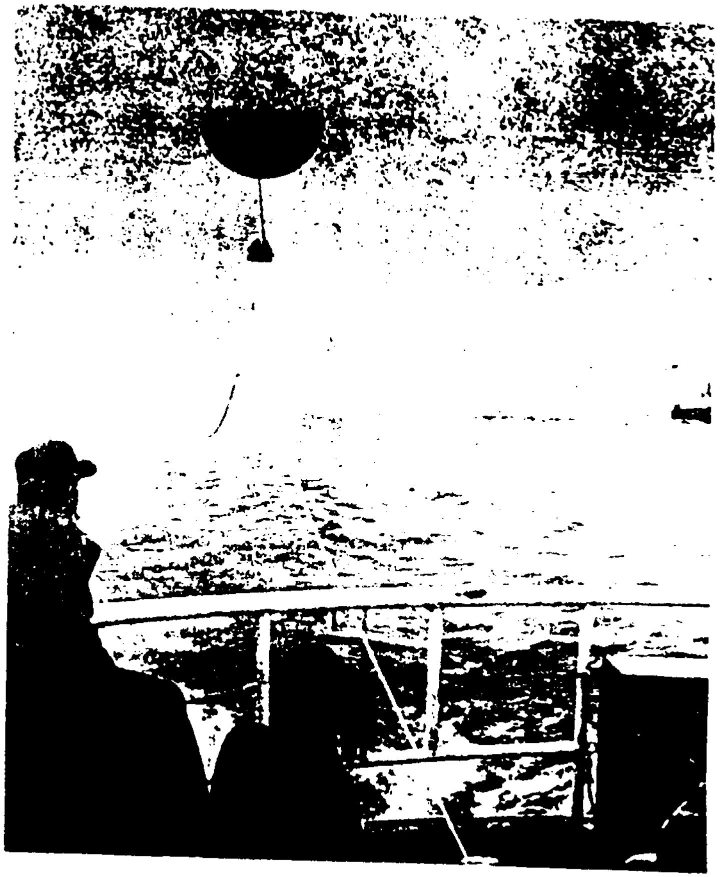

Figure 7b. The balloon "AMERICA" at sea, photo taken from the cutter Point Judith, October 10, 1977.

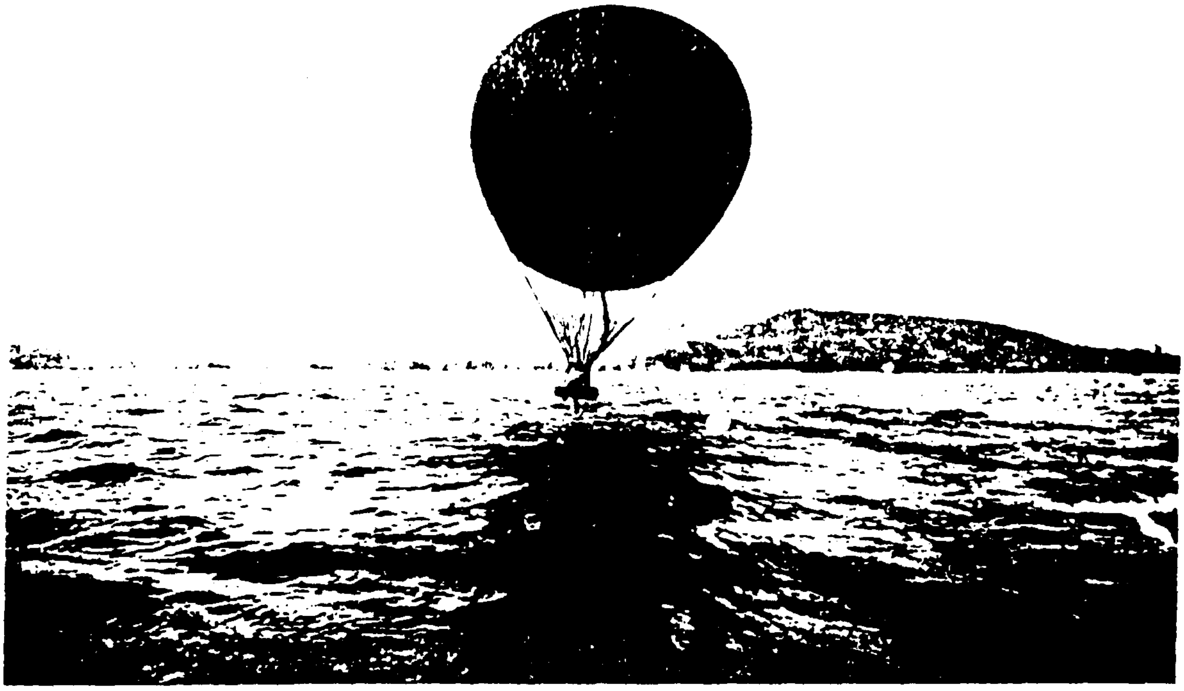

Figure 8a. The balloon "EILATI" being towed too rapidly by the Dauphin suddenly descends near Cannes, its gondola touching the sea, March 18, 1904.

Figure 8b. The balloon "AMERICA" being towed too rapidly by the Point Judith suddenly descends near Point Conception, its gondola touching the sea, October 10, 1977.

III. EQUIPMENT CONFIGURATION

A. AIRBORNE

1. BALLOON

The ATMOSAT balloon was the same as that used in the six previous flights. Extensive leak testing was conducted by Neushul, Inc., to find and repair leaks that occurred during the flight six landing in an orange grove at Redlands, or that escaped detection during the preflight six leak test. The testing was conducted over the period of October 4 to 6 in the Marine Corps' Lighter Than Air facility at Santa Ana. The results are shown in Figure 9. No large leaks or tears were found in the balloon. Rather, it appears that there is a general degradation of the mylar outer layer of the balloon's envelope that results in many small leaks. Leak testing located some 150 small leaks, each of which was sealed with Winzen balloon patching tape. Tests of the helium valve, balloon harnesses, and thermistor array were all nominal.

2. GONDOLA

The same gondola was used for this flight as was employed during the contract flights for the SCAQMD, a kevlar/aluminum structure built by Neushul, Inc. The onboard communications array was enhanced by the addition of a 55-channel marine band transceiver to provide ship-to-balloon and balloon-to-shore communications. Details of the other instrumentation can be found in Appendix B.

3. RIGGING AND HANDLING LINES

The major departure in the flight configuration from that used on earlier flights was the "de la Vaulx" rigging designed to allow various marine operations. A synopsis of this equipment is given below. Figure 10 shows the ensemble of rigging lines in operation.

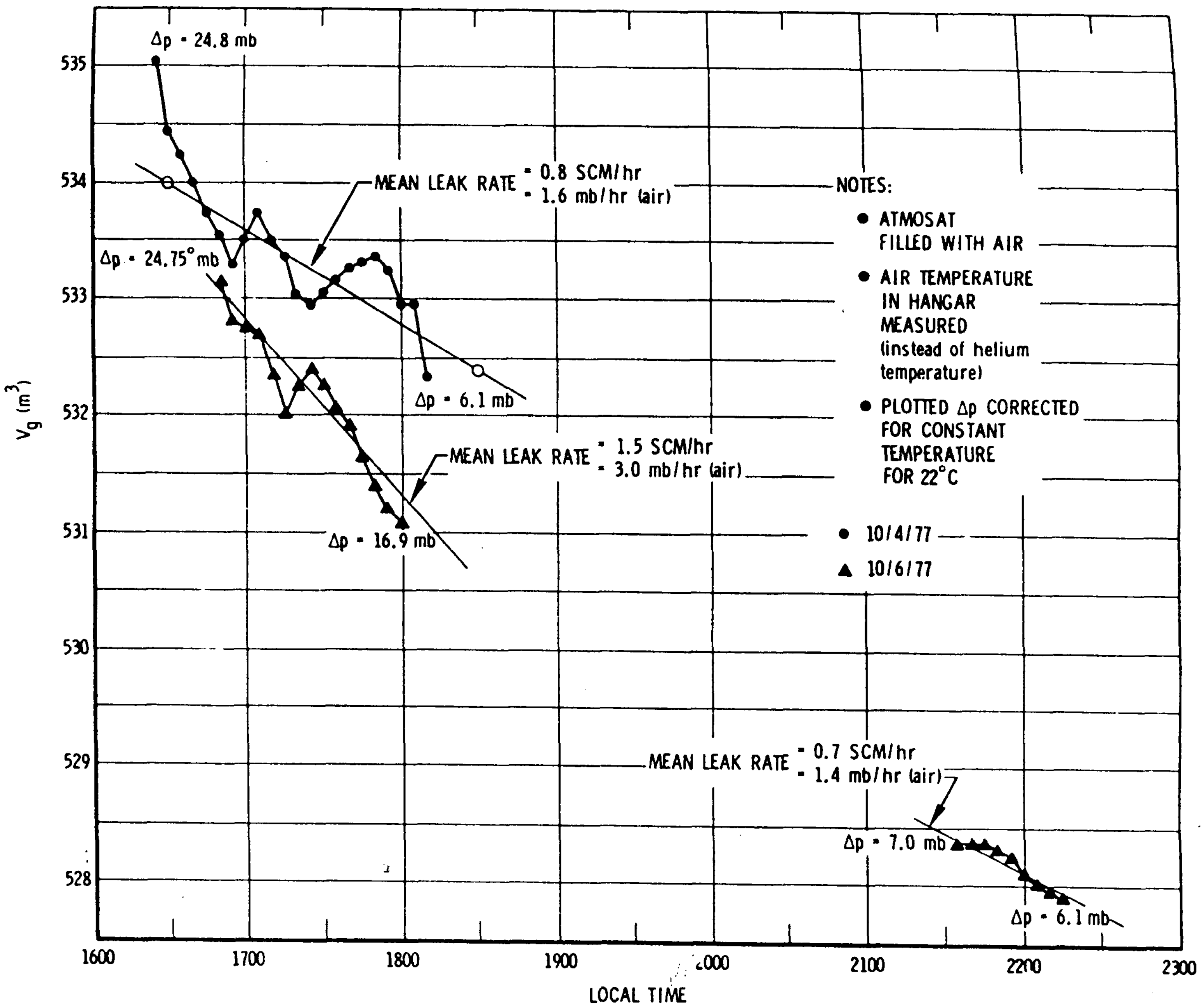

Figure 9. ATMOSAT-7 Preflight Leak Tests

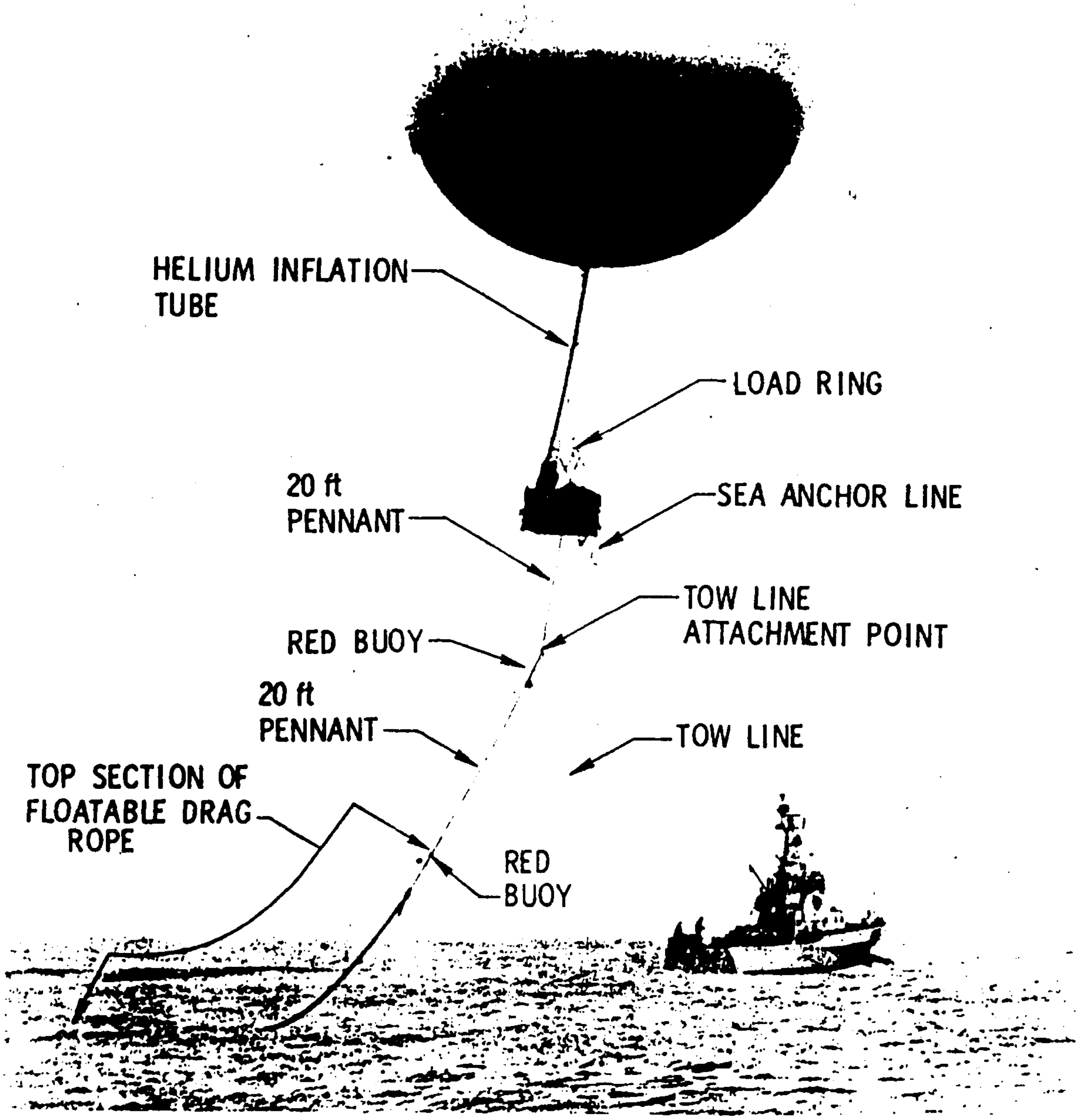

Figure 10. Rigging Lines in Operation

a. Floatable Guide Rope

Previous ATMOSAT flights had been equipped with a 100-ft, 35-lb nylon guide rope. For the planned flight it was necessary that the guide rope be floatable, and that the guide rope configuration be modifiable in flight depending upon circumstances. A 200-ft polypropylene hawser weighing approximately 350 lb was acquired for this purpose. The hawser was cut into four sections, and each end was spliced to a 5-ft manila rope pennant with an eye at each end. This yielded four 60-ft sections each weighing 90 lb. Figure 11 shows these lines on the beach of Gaviota during integration tests on October 9, 1977.

b. Tow Rope

Two 600-ft spools of 1/2-in. nylon rope were acquired for towing purposes.

c. Interface Pennants

Six 20-ft manila pennants with eyes on each end were acquired to permit proper interconnection of all rigging lines.

d. Sea Anchor

A sea anchor (see Figure 12) was prepared to allow the flight crew the option of slowing the balloon's speed in case the balloon was heading for shore in an undesirable place (without towing assistance), or if the wind speed was such that the cutter could not keep pace with the balloon.

e. Ground Anchor

A standard 5-lb marine anchor was attached to the side of the gondola to enable the crew to stop the balloon if an unassisted landing had to be made on the beach. As the balloon was not intended to overfly the land, the grappling hook previously flown as a balloon anchor was replaced with the marine anchor which would have better traction if dropped in the surf line, allowing a controlled landing on the beach.

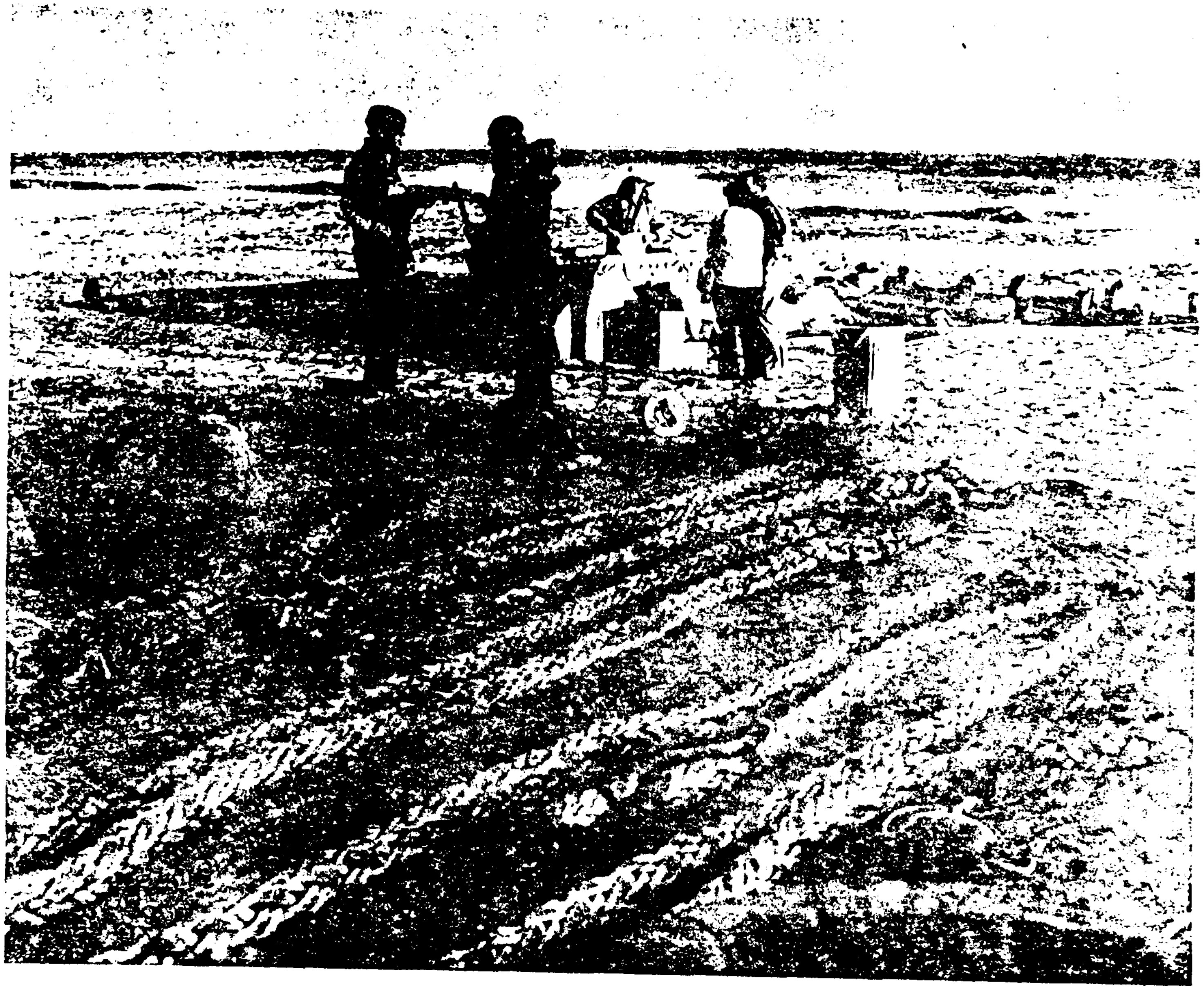

Figure 11. Floatable Guide Ropes

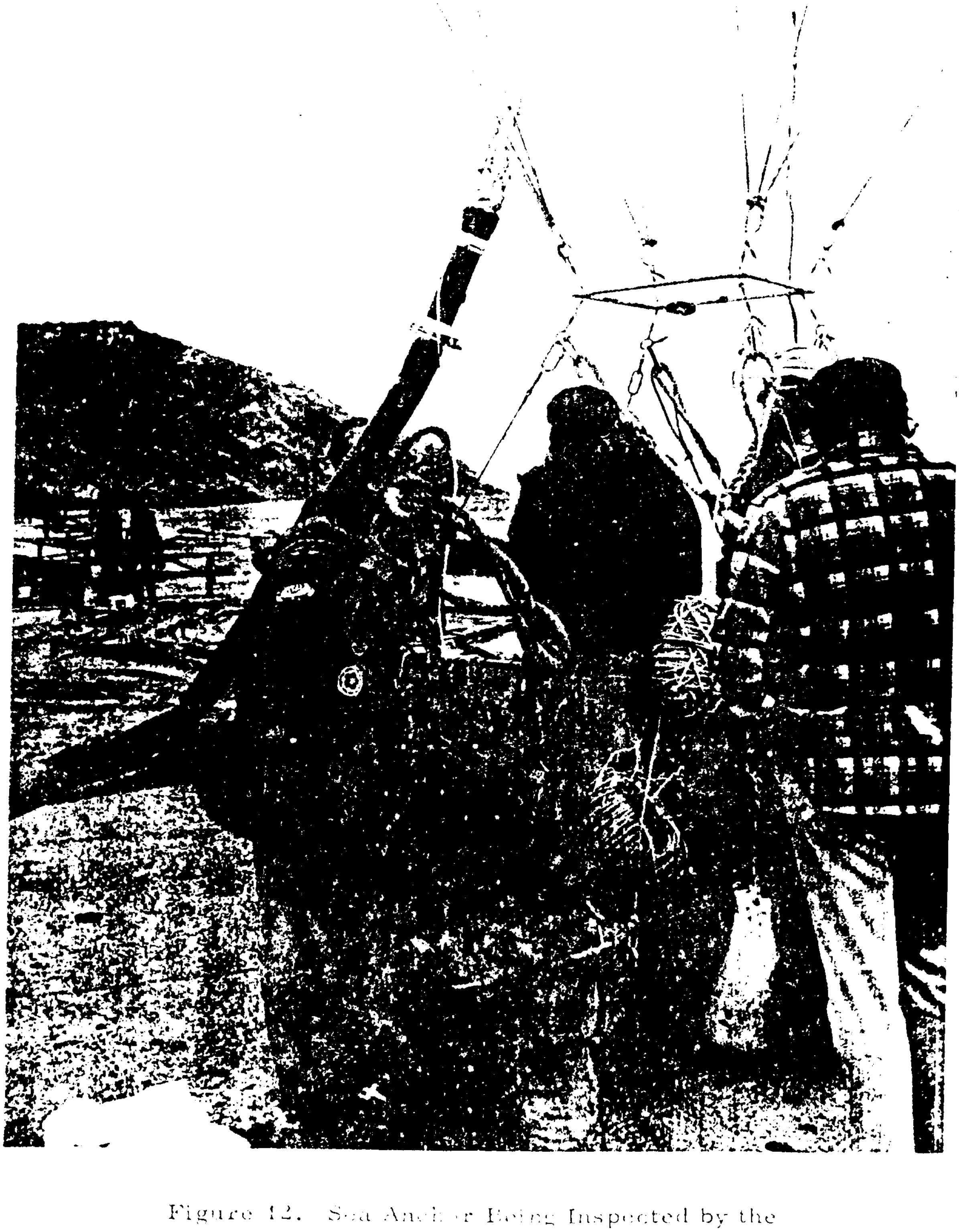

Figure 12. Sea Anchor Being Inspected by the Flight Crew

B. SHIP SUPPORT

1. U.S. COAST GUARD CUTTER

At the request of Rear Admiral R. I. Price, Commander of the Eleventh Coast Guard District, the 82-ft cutter Point Judith, stationed in Santa Barbara, was assigned to support the mission. Under the command of Lt (jg) Dan Elliot, the cutter would accompany ATMOSAT during the entire mission, towing it to the desired launch site, releasing it there, escorting it during its free flight, and if possible supporting the beach landing. Contingencies were also planned that allowed the cutter to take the balloon in tow if it were approaching the beach during the first day. In that case, the cutter would return the balloon to a desirable release point for another free flight. The cutter and its crew of seven officers and crewmen were prepared to support a flight of up to 48 hours. Arrangements were made to allow the cutter to carry mission personnel from the Harbor Department of the City of Long Beach, the Public Utilities Commission, the SCAQMD, and The Aerospace Corporation.

2. COMMERCIAL VESSEL

To complement the Coast Guard cutter during the first few hours of the flight, a commercial vessel, the 65-ft Summer Tide, was leased in Santa Barbara. The vessel was to carry additional project personnel and to assist the mission as might become necessary as an escort vessel, then return to Santa Barbara during the afternoon of the first day.

IV. COMMUNICATIONS NETWORK

Three independent communications systems were available for flight seven: the Los Angeles County UHF communications network, the Marine Band UHF network, and the FAA Aeronautical Band VHF network. Each system is described below and illustrated in Figure 13.

A. L.A. COUNTY UHF COMMUNICATIONS NETWORK

The L.A. County Communications Department set up a portable UHF repeater station at a site overlooking Santa Barbara. An additional repeater station at Verdugo Peak above the city of Glendale was used by the department. Both repeaters had directional antennas mounted on the towers for maximum gain. UHF console transceivers were located at the balloon control center (at SCAQMD) and on board the Coast Guard cutter Point Judith. Handheld transceivers were used by the balloon, the escort vessel Summer Tide, and the Aerospace chase vehicle.

B. MARINE BAND UHF NETWORK

The cutter, escort ship, and the balloon were each equipped with 55-channel Marine Band transceivers. Some balloon-to-ship communications were exchanged on Channel 16, the hailing frequency. More importantly, extensive use was made of the commercial radio-telephone service provided through the Santa Barbara Marine Operator on Channel 25. This put the balloon and the ships in direct voice contact with the SCAQMD control center via landline telephone connections at Santa Barbara. This also allowed the SCAQMD weather analyst on board the cutter to collect meteorological data from shore stations. The balloon crew used the service to relay data back to the control center and to answer press inquiries.

C. FAA AERONAUTICAL BAND VHF NETWORK

The balloon carried its standard 720-channel Aeronautical Band transceiver that could have been used to contact aircraft, airports, or other FAA facilities if necessary. It also could have been used to contact

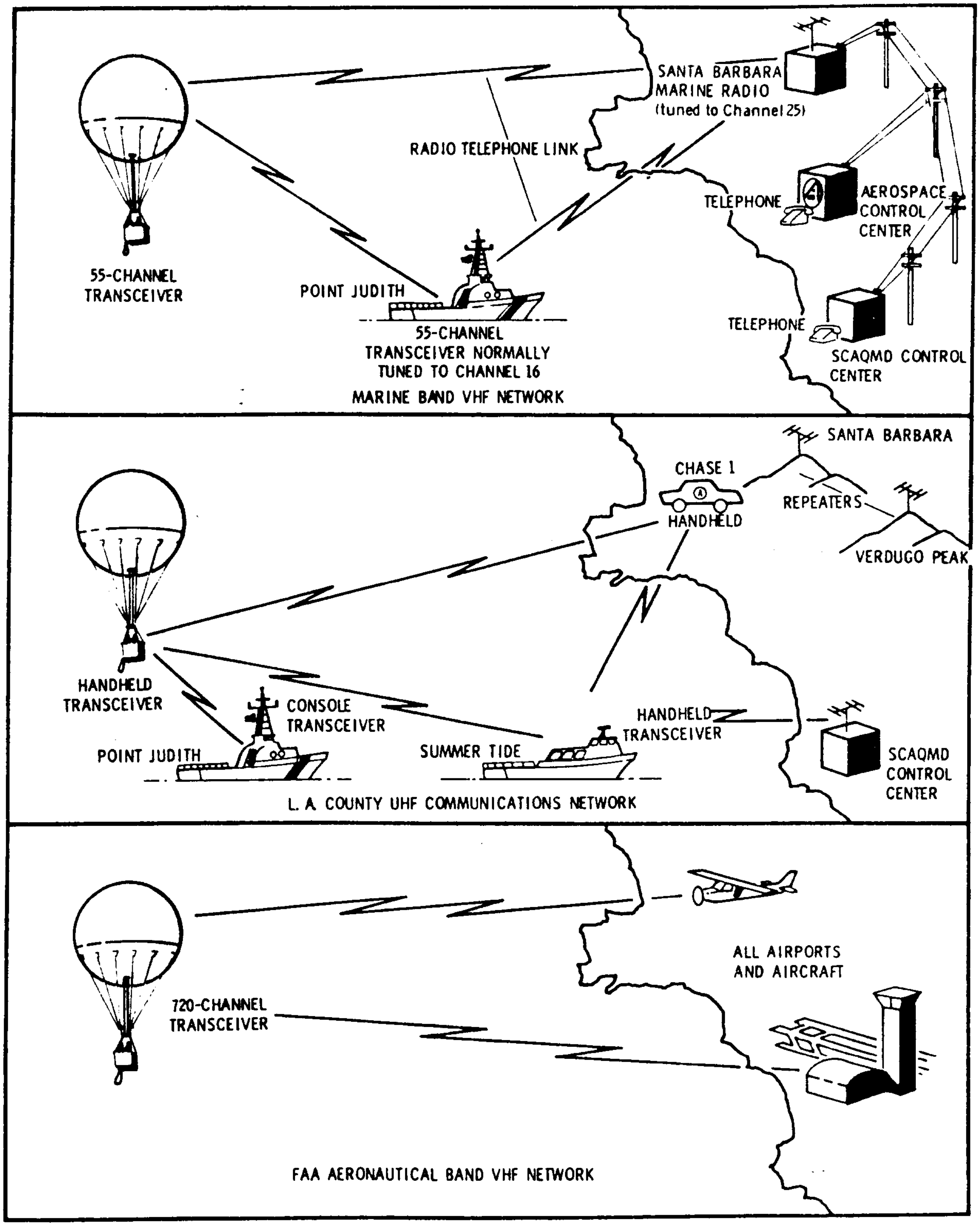

Figure 13. ATMOSAT-7 Communications System

Aeronautical Radio, Inc. (ARINC) to transmit messages to either the Aerospace or SCAQMD control centers. As the other two systems worked flawlessly, and the mission (as planned) remained over the ocean at all times, this network was not used. The balloon-borne equipment served only to make several OMNI position fixes late in the flight.

V. NARRATIVE OF FLIGHT 7 EVENTS

A. OCTOBER 6 TO 9, 1977

The balloon inflation site (Gaviota State Park Beach) was suggested by Mike Neushul of the University of California (Santa Barbara). A site survey by Aerospace Corporation (Dave Blakeman) on Thursday October 6, 1977, confirmed that the site was appropriate, and resulted in a clearance for the use of the beach for balloon inflation and launch. During that trip Mr. Blakeman also visited the Point Judith and briefed its crew on the intended operational plan.

As preparations were proceeding rapidly, the first possible launch date was chosen as Monday morning, October 10, 1977. A weather briefing by the SCAQMD (Art Davidson) on Sunday morning, October 9, confirmed that weather conditions for the following day should be appropriate for the mission. Equipment and personnel were then dispatched to Gaviota.

B. OCTOBER 9, 1977 - 1600 TO 2000*

By 1600 on October 9, all the equipment had arrived at Gaviota and was unloaded on the beach. A 40 × 40 foot tarpaulin was placed on the beach above the high water line, and the gondola positioned on the upwind corner. Sand bags were filled and placed around the edge to hold down the tarp, a precaution made necessary by the 10 to 15 knot breeze sweeping seaward across the beach. While gondola equipment was installed and integrated, the balloon was stretched out on the tarp and then covered with a second 40 × 40 ft tarp. Integration and testing continued until 1845 when it was decided to move the balloon and gondola to a concrete pad at the beach edge of the parking area, where the helium truck could easily be positioned, and where no unusually high waves could reach the balloon during the night. Once on the pad, the gondola was mechanically and electrically connected to the balloon, and the electrical tests of the helium valve and thermistor array were accomplished.

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*All times in this report are local Pacific Daylight Time (PDT)

By 2000 the system was ready for helium delivery, which was planned for first light the following morning.

C. OCTOBER 10, 1977 - 0400 TO 0930

The helium truck arrived as planned at 0400 and was positioned to allow prompt hookup to the balloon when inflation was to begin.

At 0600 the weather analysts of the SCAQMD gave an OK for the operation. Arriving at the launch site, the inflation crew was dismayed to find that a 15-knot wind channeled down the Gaviota canyon in an area where otherwise, for miles around, the air was calm. By 0700, however, the winds were down to 8 to 10 knots (with a few gusts to 12) and the decision to inflate was made.

A belly band was placed around the balloon to prevent spinnaker action (wind inflation) during the early phases of inflation. The initial inflation phase left something to be desired as two problems quickly developed: (1) the helium was not being properly channeled into the upper portion of the balloon; and (2) the belly band was not sufficiently strong. As can be seen in Figure 14, the balloon inflated in two parts, under ideal conditions the upper half alone is allowed to inflate, the lower half being held empty by placing weights on the envelope. This "double-bubble" was not judged to be a significant problem during this inflation. The second problem could have been more serious had the wind been stronger. The belly band is equipped with a quick release device actuated by jerking on a cord held by one of the inflation crew. As the balloon became sufficiently buoyant to stand erect, the belly band parted prematurely, without anyone actuating this release. This caused the spinnaker formation as seen in Figure 15. When this happens one of two actions must be taken immediately, activation of the electrical helium dump valve (at the top of the balloon), or more rapid transfer of helium into the balloon to give it greater buoyancy and prevent the wind from blowing the balloon into the ground. The second choice was made, and the balloon rapidly gained sufficient lift to be out of danger. Manual restraint of the balloon by means of a control line fastened to the bottom plate of the balloon envelope was also utilized.

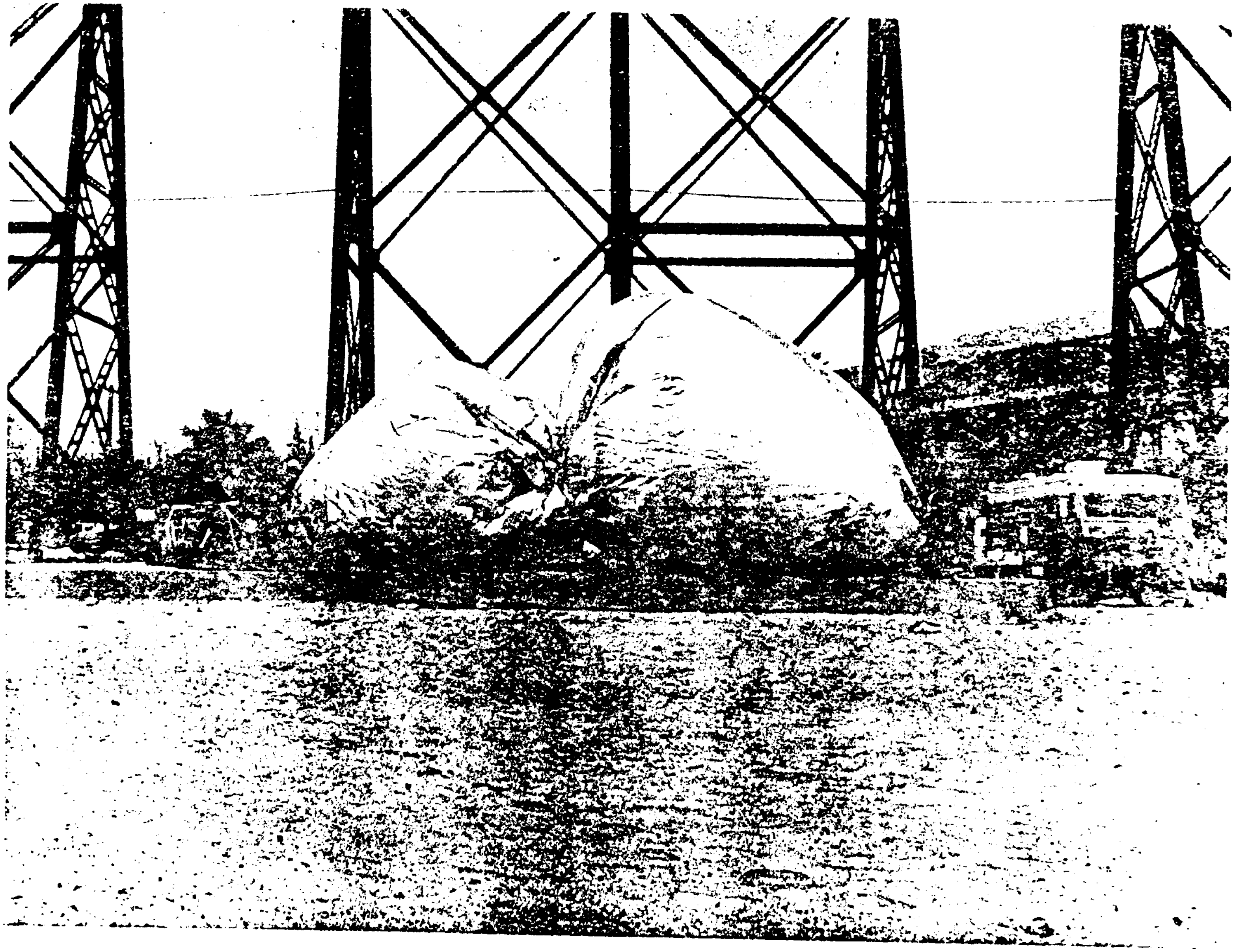

Figure 14. Initial Inflation Showing Belly Band

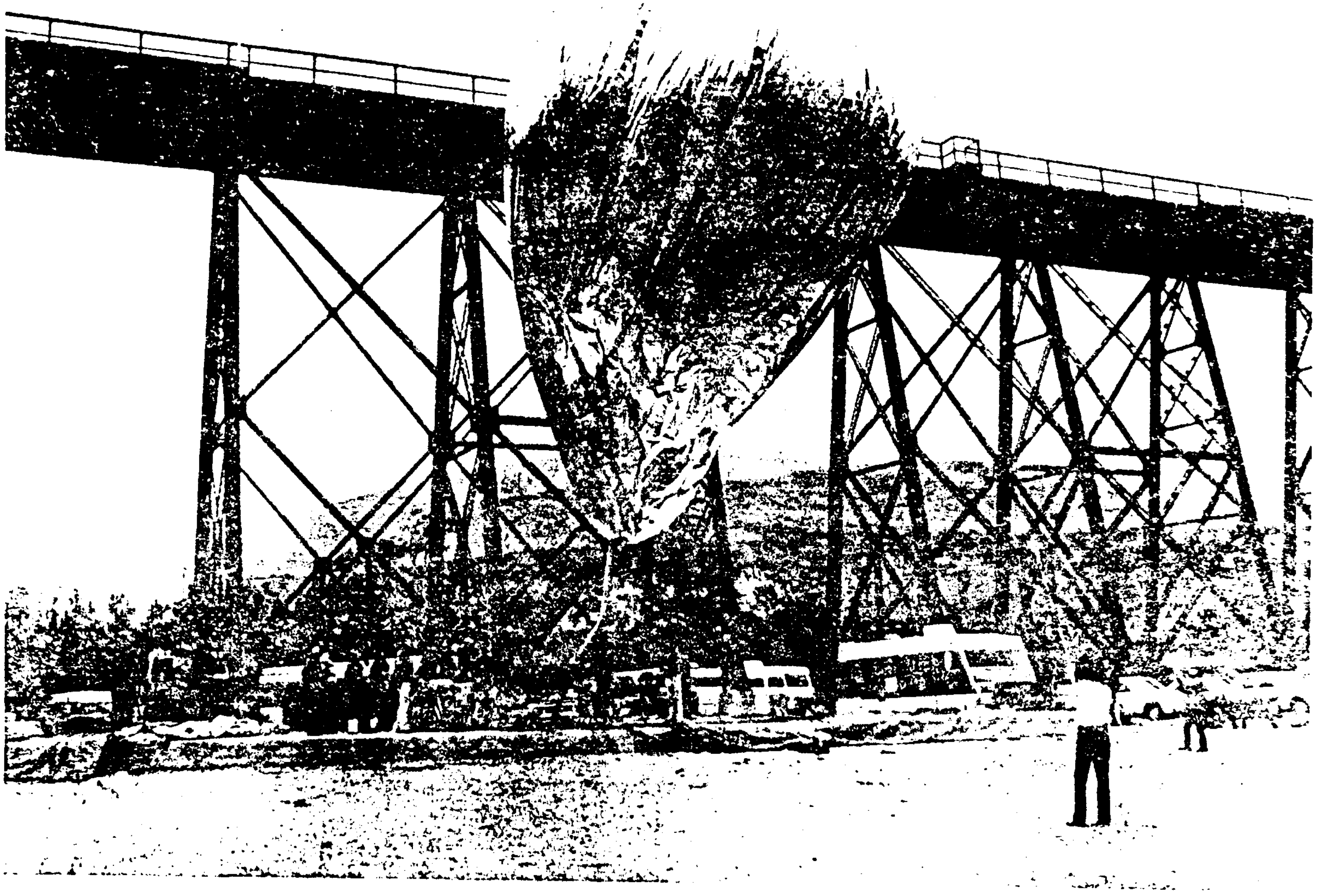

Figure 15. Initial Inflation After Belly Band Separation

Readiness activity was continued until 0909, when a pressurization test was made, and the balloon was declared ready (see Figure 16). These activities included:

- inflation and continued checkout of the balloon/gondola
- transfer of equipment and personnel from the shore to the ships using the cutter's auxiliary AVON dinghy
- layout and interconnection of the rigging lines
- UHF and VHF communications checks
- photography of all aspects of the ongoing activities
- calibration of onboard equipment

The line from the cutter, the Point Judith which had arrived along with the Summer Tide at 0741, to the balloon was attached at 0919, after which final personnel transfers to the Point Judith and the Summer Tide were made preparatory to liftoff. (Note - details of this activity are found in Appendix C, which summarizes the recordings taped on board the balloon.)

D. LIFTOFF

By 0930 all was in readiness, with all personnel at their proper stations on the beach, onboard the ships, in the balloon, in the chase vehicle that would follow the operation from shore, and the control center in downtown Los Angeles; a final GO was given, and the mission commenced. A 90-lb, 50-ft-long section of floating guide rope (a braided polypropylene cord) was stretched out on the beach aimed at the cutter (see Figure 17). With the tow line attached between the load ring and the cutter, the ATMOSAT dropped several sand bags until she lifted approximately 30 feet into the air, stabilized by the weight of the guide rope on the sand, and by one control line being held by a member of the launch crew. At 0938 the cutter pulled the tow line taut (see Figure 18), the control line was released, and the mission was underway. Photographs of the liftoff and the start of the towing operation are shown in Figures 19 and 20.

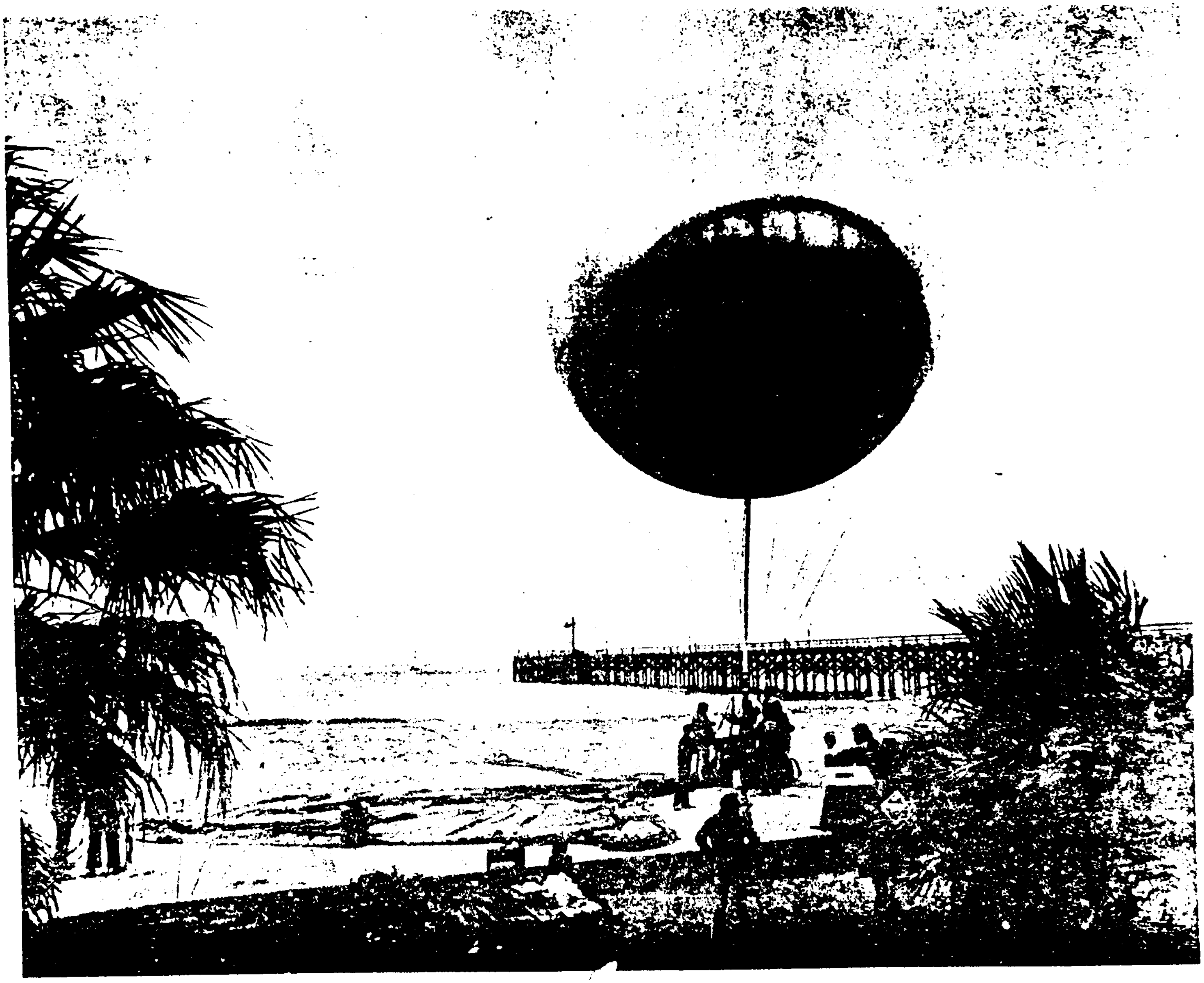

Figure 16. ATMOSAT "America" Just Prior to Launch

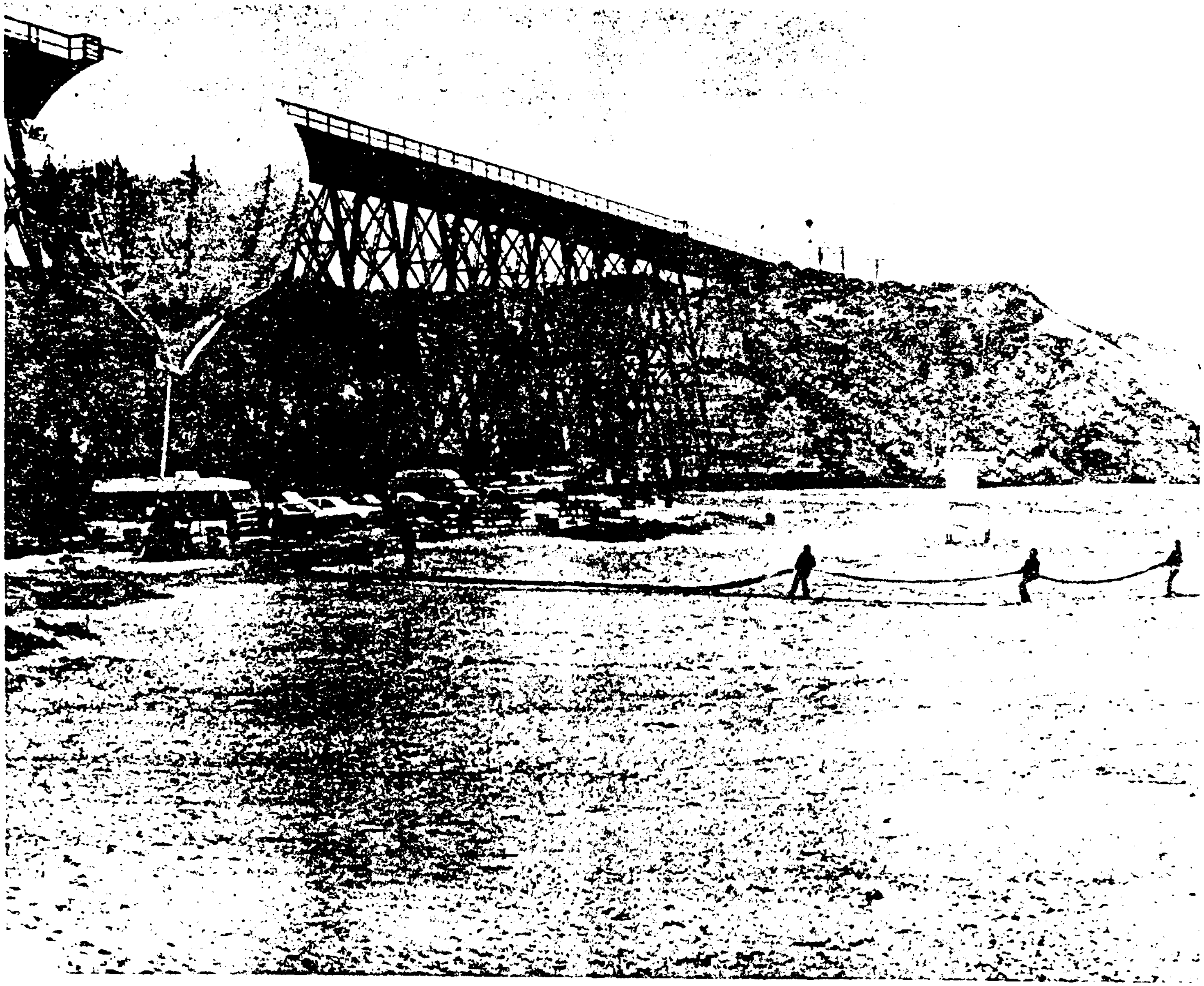

Figure 17. Floating Guide Rope Being Stretched Out on the Beach

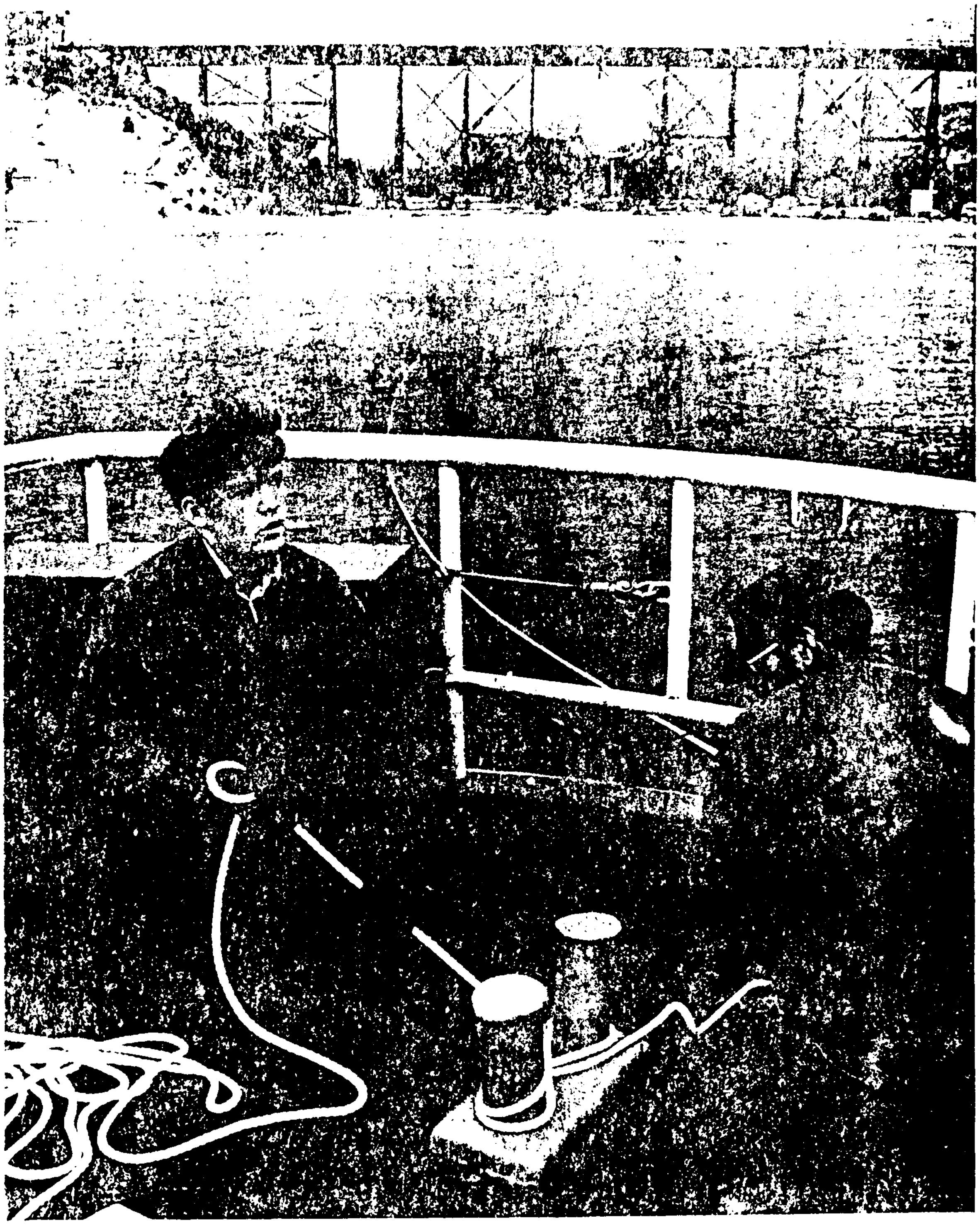

Figure 18. Coast Guardsmen Pulling Tow Rope Taut

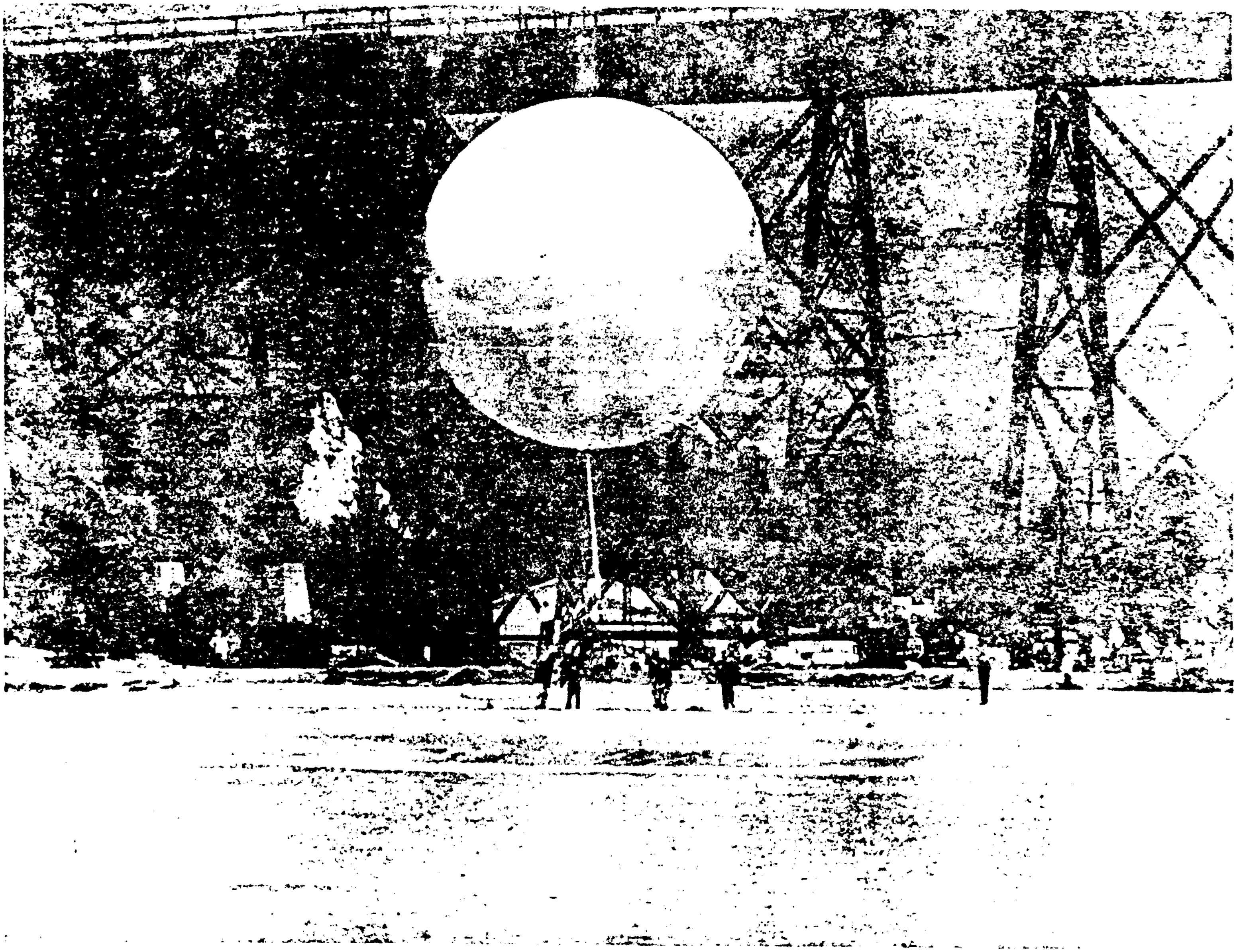

Figure 19. Liftoff from Gaviota Beach

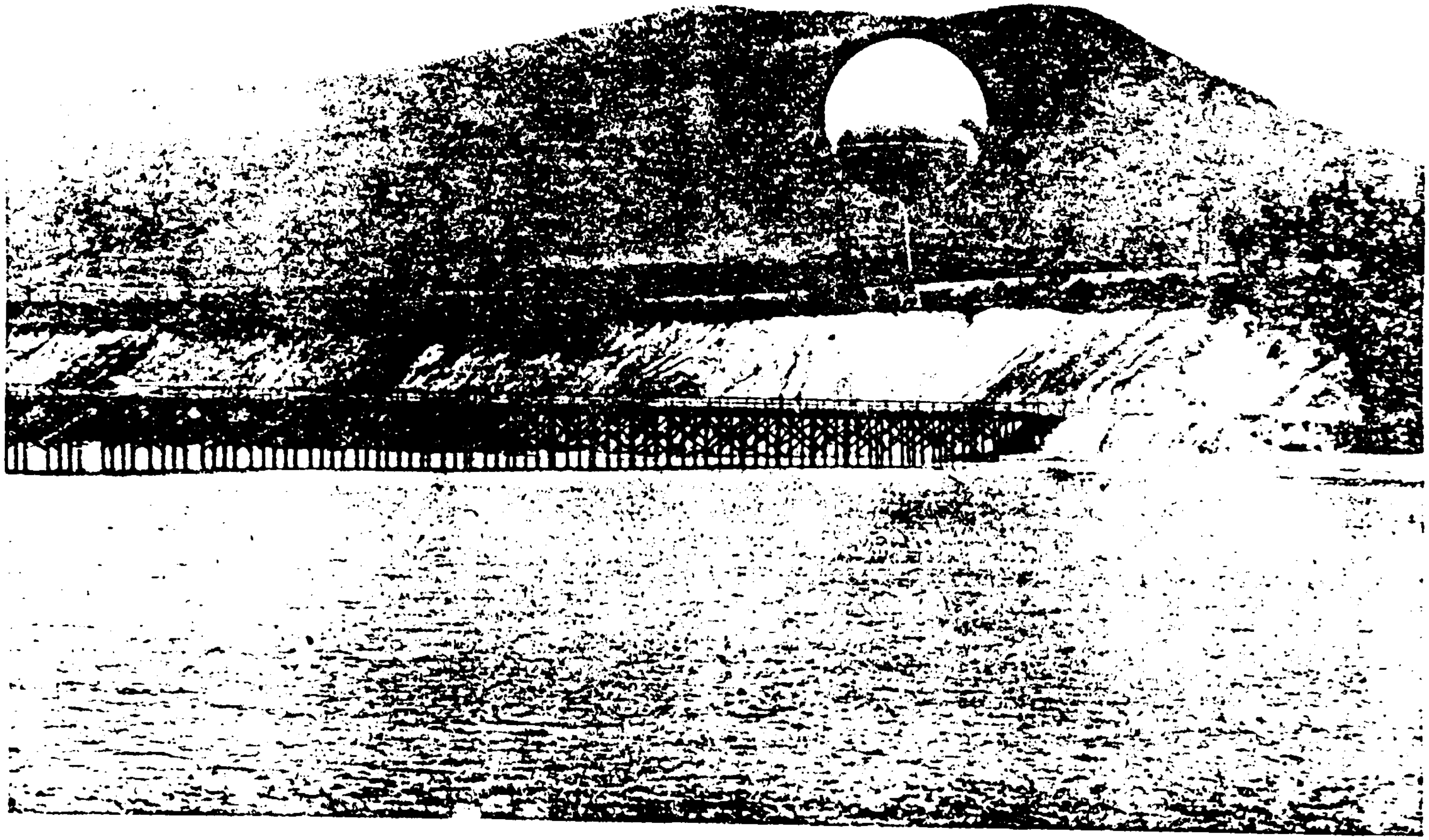

Figure 20. Start of the Towing to Launch Site

E. INITIAL TOWING OPERATIONS

The flight crew (Tom Heinsheimer and Pete Neushul) kept an eye on their altitude. Though launch was effected with a 6-knot land breeze, they knew that when the shoreline was left behind the wind would revert back to the northwest creating a greater drag on the tow line and, perhaps, causing sudden fluctuations in balloon altitude. Another bag of sand was soon sent over the side as altitude oscillations started.

While less than a mile from shore, an unexpected problem arose; the convoy passed through a kelp bed. The tow lines and the drag rope became snagged with the heavy kelp. As the cutter slowed to a near standstill, the Summer Tide closed with the snagged lines, recovered the lines, and freed them from the kelp. It should be noted that the oscillations in the lines as the Summer Tide crew shook the kelp free were transmitted to the balloon and were extremely uncomfortable. Photographs of this operation are shown in Figures 21 and 22.

With the kelp bed left behind the cutter's speed was increased. At 10 knots airspeed a sudden oscillation ended in a SPLASH. The gondola rebounded immediately from the sea and the cutter backed down. The crew reviewed the rigging status and asked the cutter to release more tow line. Another bag of sand was dumped overboard and towing was resumed at a speed of 8 knots.

The flight plan required the balloon to fly superpressurized at 200 to 250 feet altitude during the entire mission from release by the cutter to arrival on shore. Care had to be taken not to put out too much ballast, for if the balloon became positively buoyant with all of the guide rope out of the water, then later, when the tow line was let go, the balloon would ascend rapidly to an altitude too high for the mission. To come back down would require releasing of the superpressure in the balloon and then venting of helium. When the balloon returned to the desired altitude it would no longer

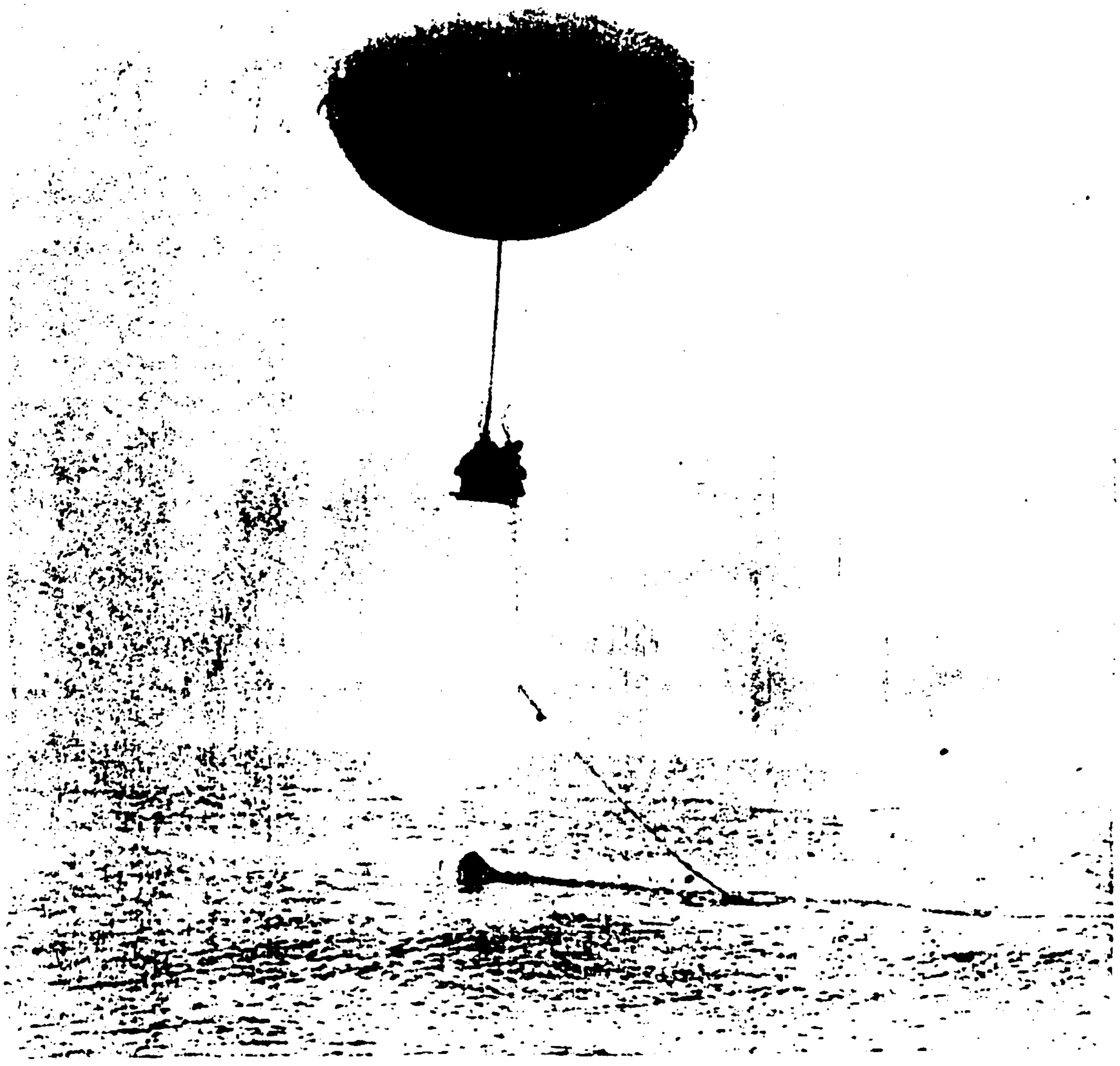

Figure 21. Tow Line Snagged with Kelp

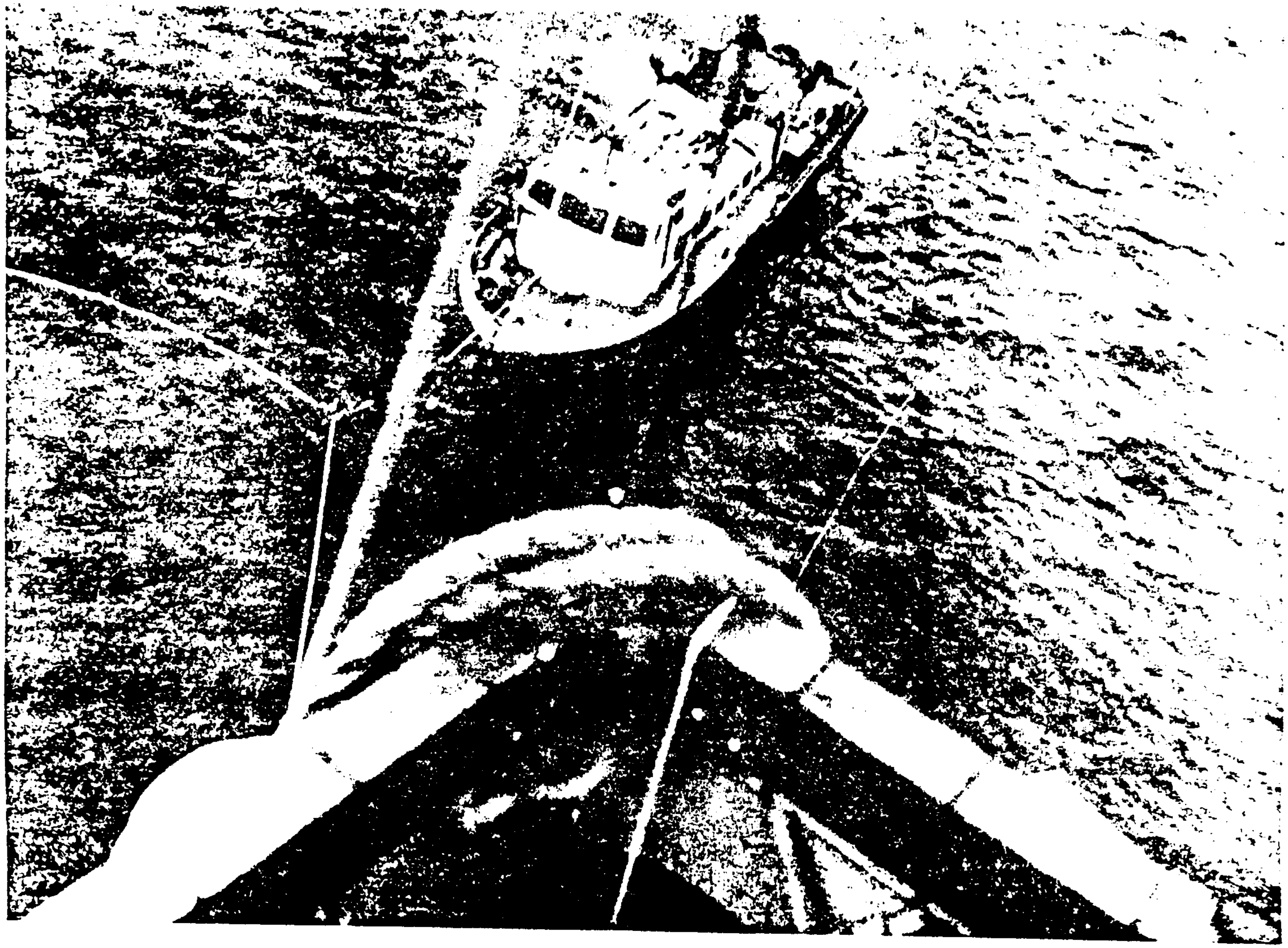

Figure 22. Summer Tide Crewman Shaking Kelp from Tow Line

be superpressurized, losing the stability needed to maintain the narrow altitude limits.

This ballast constraint meant that to raise the flight altitude, in order to allow a faster towing speed, a longer and heavier guide rope would have to be used or the balloon would have to be winched down and a crew member off loaded to lighten the payload. At 1057 the convoy slowed again in an attempt to winch the balloon down to the cutter. Before the winching started, the crew analyzed the stability problem and estimated that with a sufficiently long tow rope and a second floating guide rope a towing speed of 10 to 12 knots could be achieved with two crew members on board. The Summer Tide was requested to fish the end of the drag rope out of the water and pass it to the cutter so that the second guide rope could be attached and the balloon winched down. The balloon crew requested 100 ft of nylon line be inserted between the first and second floatable guide ropes. This extended the total length of the floatable guide rope array to approximately 240 feet, sufficient (it was hoped) to allow speedier towing.

The second guide rope assembly was successfully attached. With the gondola winched to within 100 feet of the cutter's deck, the decision was made to abandon the attempt to land the balloon on the cutter because of excessive gondola rotations. The balloon was let out slowly on the tow rope again, and as three more bags of sand were put out of the gondola, 1100 ft of tow rope was deployed. As had been expected, the new configuration allowed safe towing at wind speeds of 12 to 14 knots, sufficient both for the transport to the release site and for any eventuality requiring emergency towing during the mission. Figure 23 shows the configuration during this phase. Figure 24 shows the radar and pressure altitude profile recorded on board the ATMOSAT during the towing operation.

F. FREE FLIGHT

At 1245 PDT the convoy reached the release site, the northern end of the Santa Barbara shipping channel, off of Point Conception. The weather was overcast with a 700-ft stratus ceiling that was not expected to disperse during the day. To keep the balloon from going too close to the ceiling, the

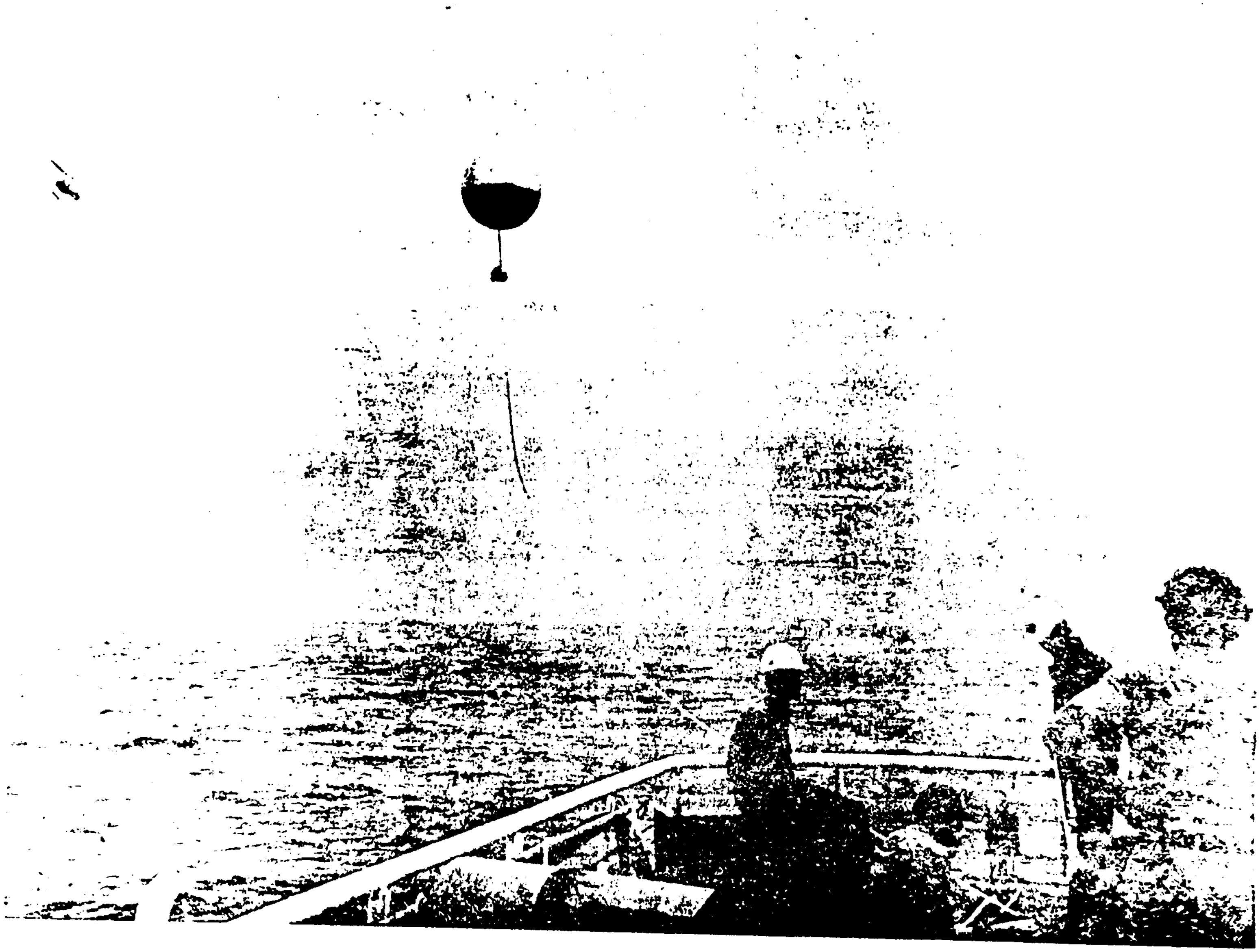

Figure 23. ATMOSAT-7 Just Prior to Release

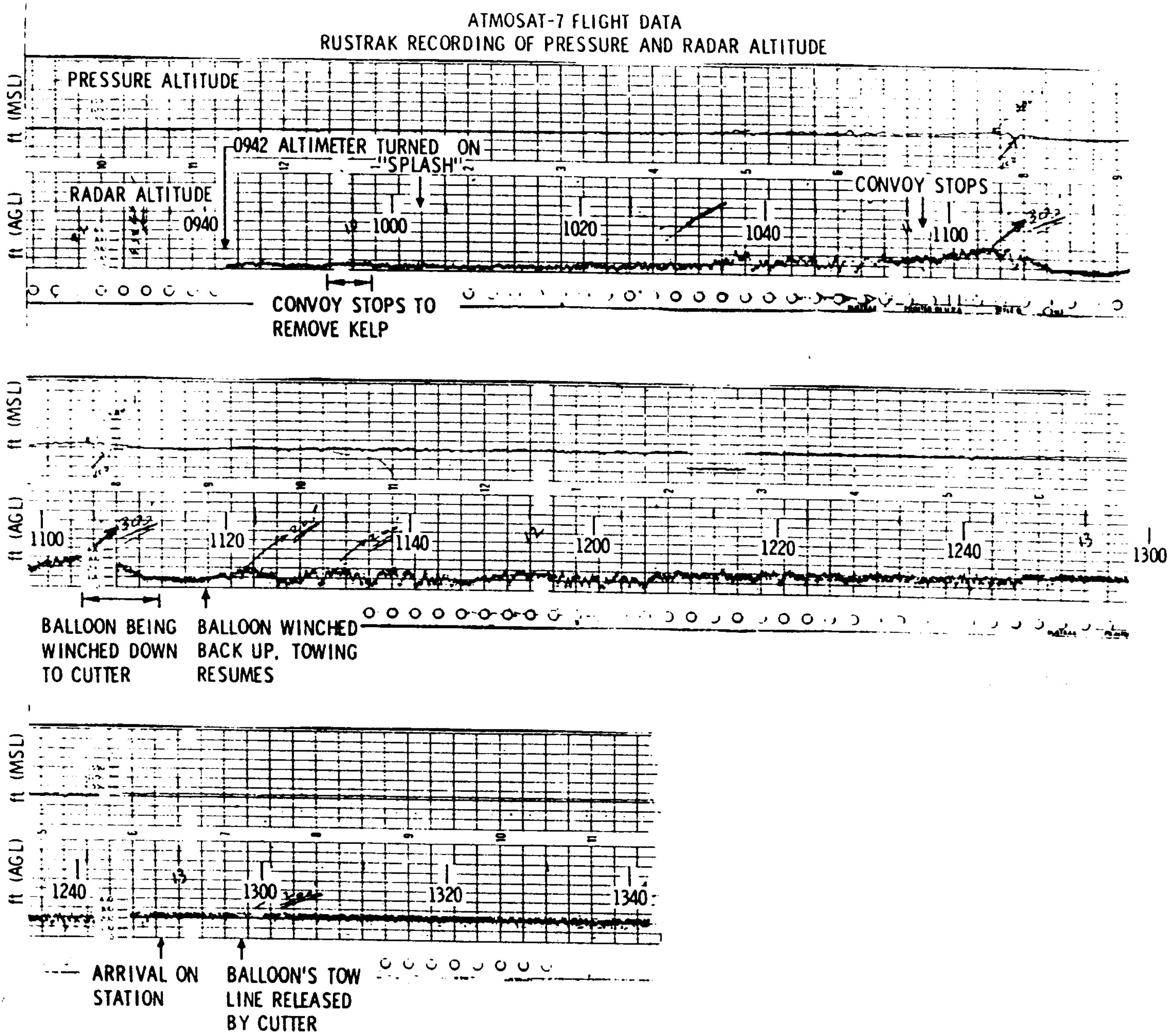

Figure 24. Radar and Pressure Altitude Profile

system was weighed off about 20 pounds heavy, so that the lower end of the guide rope just trailed in the water. Before the tow rope was released, a large Coast Guard buoy was attached to the end of it. The tow rope was released at 1258; "America" was in free flight.

With the two escort vessels in pursuit, "America" floated down the shipping channel at 7 knots for the first four hours. At 1600 the balloon dropped a line to the Summer Tide in order to pull up more sand bags. After the first sand bag was attached, the line became tangled with the tow rope partly because the line was thrown outboard from the Summer Tide in such a manner that its trajectory crossed the tow line and the line had to be cut. Shortly after this incident the cutter's inflatable dinghy was launched in an attempt to cut the buoy from the end of the tow rope, which in bouncing from wave to wave was causing oscillations. Because of the four-foot waves, it took the crewmen four trys before the buoy was released. Photographs of the free flight are shown in Figure 25.

At 1645 the passengers who were not staying the night on the cutter were transferred to the Summer Tide in the dinghy. The Summer Tide departed at 1700. Soon thereafter the balloon's progress became less and less rapid, finally slowing to 2 to 3 knots as nightfall approached. As the balloon's vertical oscillations were lifting the entire floatable guide rope out of the water, it was decided to add a third floating guide rope.

The remoteness of the site, the total absence of moonlight, and the thick cloud cover all contributed to produce an unusually dark night. With the ceiling still at 700 feet but threatening to descend, and a visibility into the surrounding haze of 1 to 2 miles, there was nothing to be seen from the balloon but the flashes of the "America's" strobe light and the running lights of the Point Judith. At 1900 the flight crew was informed that the radar officer had determined that "America" was on an apparent collision course with an off-shore oil platform. After a quick radio consultation it was decided not to drop ballast (thereby sending the balloon into the clouds)

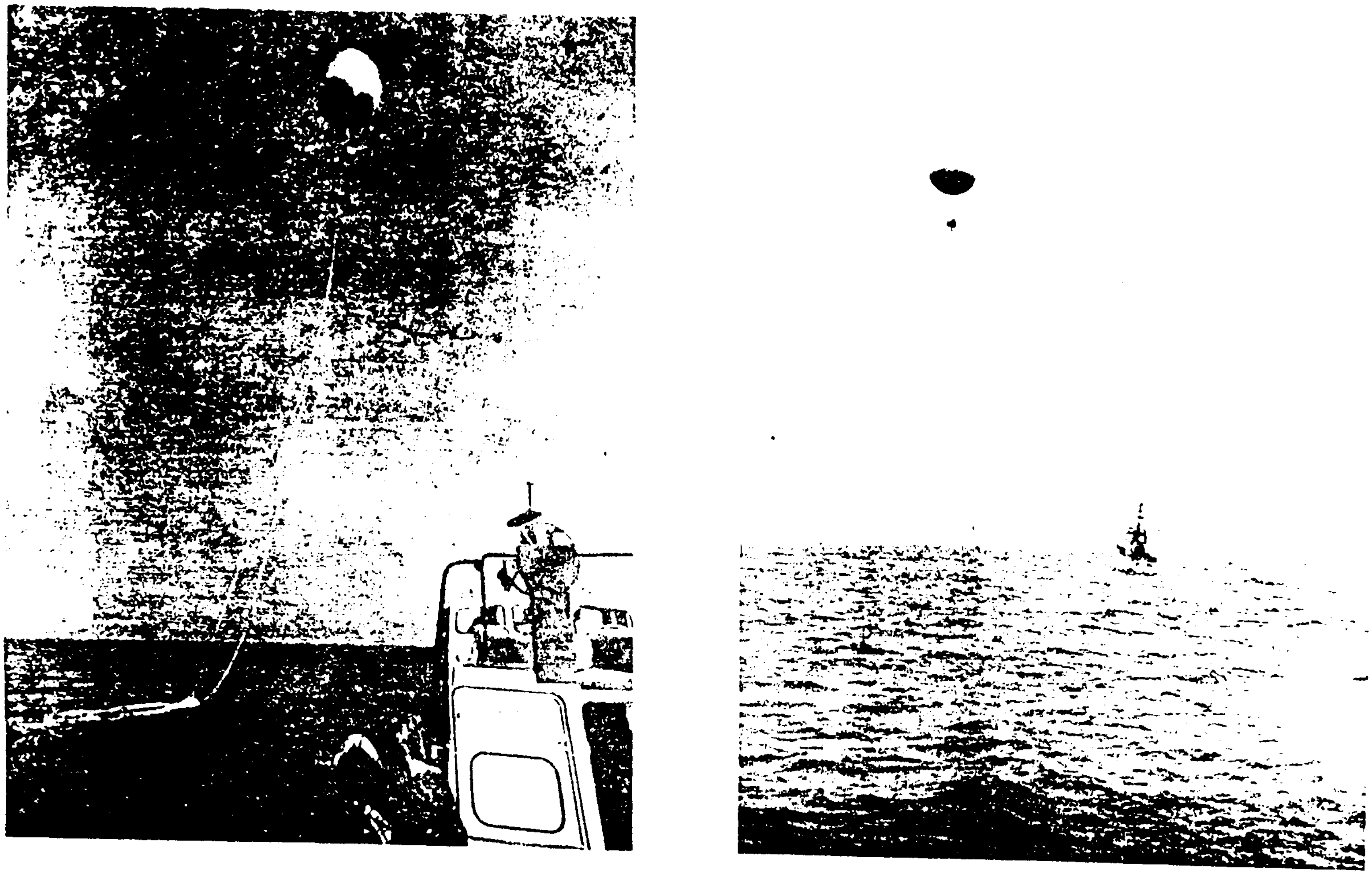

Figure 25. Free Flight in Santa Barbara Channel

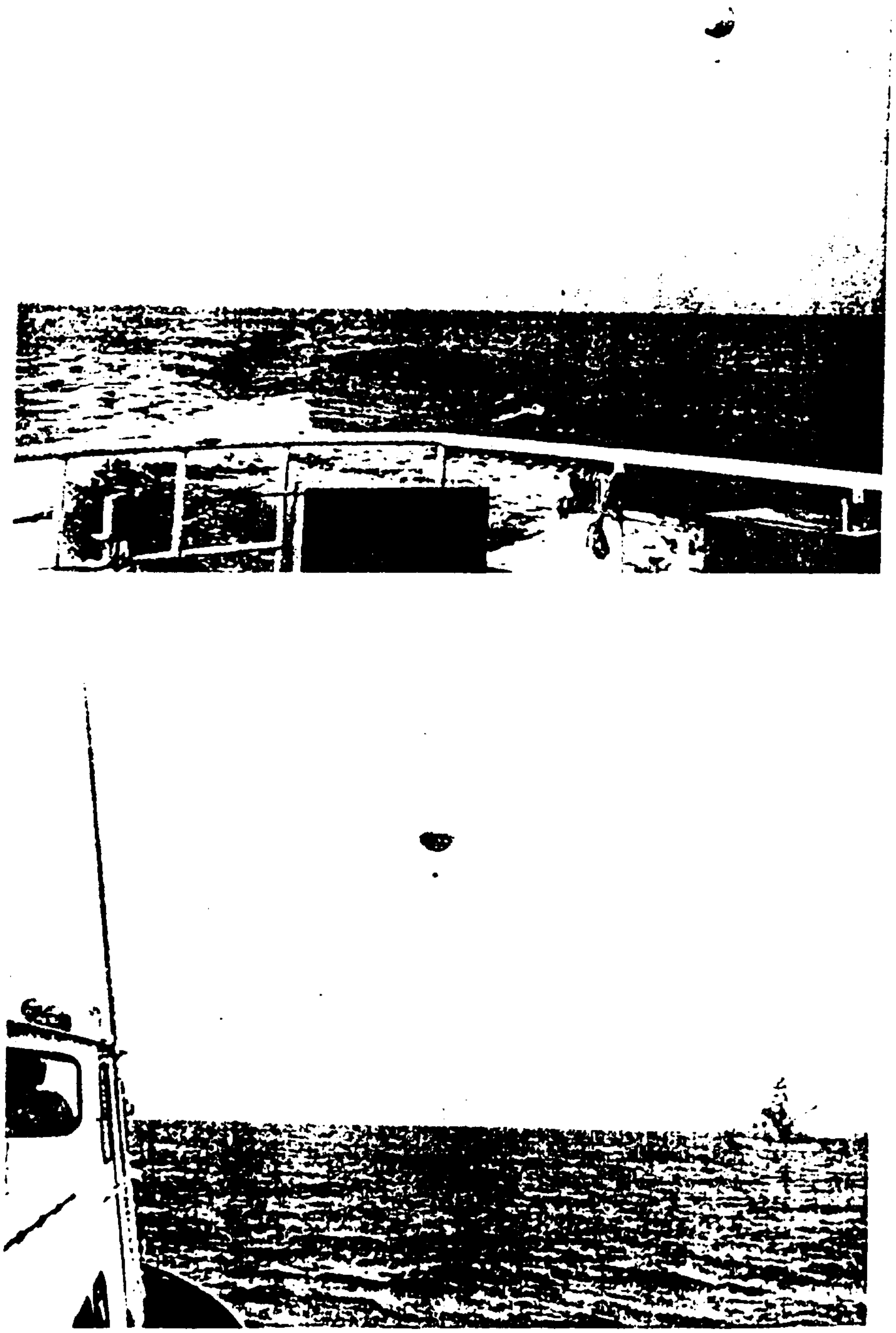

Figure 25. Free Flight in Santa Barbara Channel (Continued)

but to capture the trailing guide rope and to guide the balloon around the obstacle. As the lights of the tower emerged from the haze, the Point Judith captured the guide rope and slowly pulled the balloon north of its previous trajectory until it was well clear of the platform. The vigorous rocking motion imparted to the gondola by this operation caused copilot Pete Neushul to become the first superpressure balloon pilot to become seasick in flight. To his great relief the tow line was released at 1943 as the tower passed to starboard, then faded slowly back into the haze.

Soon thereafter the balloon was virtually becalmed, making only about 10 miles all night on a meandering course. The early morning hours brought no change in the weather, still overcast and hazy with little wind. Time was spent on the Marine Band radio returning the calls of radio news reporters.

G. FLIGHT TERMINATION

By noon the sky was brightening and soon the sunshine started to burn through the overcast. With the sunlight came the strengthening sea breeze that soon was propelling the balloon towards shore at 6 to 8 knots. At 1530 land was sighted. At 1550 the cutter again took hold of the guide rope, bringing the balloon to a standstill just over the surfline, while the cutter itself stayed 400 yards off-shore. A helicopter flying northward along the beach at balloon altitude passed obliviously within 200 yards of the balloon, and a speedboat racing south along the surfline heard the cutter's siren just in time to veer off before passing over the tow line. A suitable landing site was chosen and a final 100 yards of line was released by the cutter, bringing the balloon over the beach. The cutter maneuvered parallel to the beach with the balloon gradually moving inland and parallel to the beach until it was over the selected landing site. A heavy hand on the valve was needed to bring down the balloon, buoyed as it was by some 180 pounds of drag rope in the air. With the help of the chase crew, the balloon came down to a smooth landing on the sand at Oxnard Shores. Photographs of the approach and landing are shown in Figures 26 through 29.

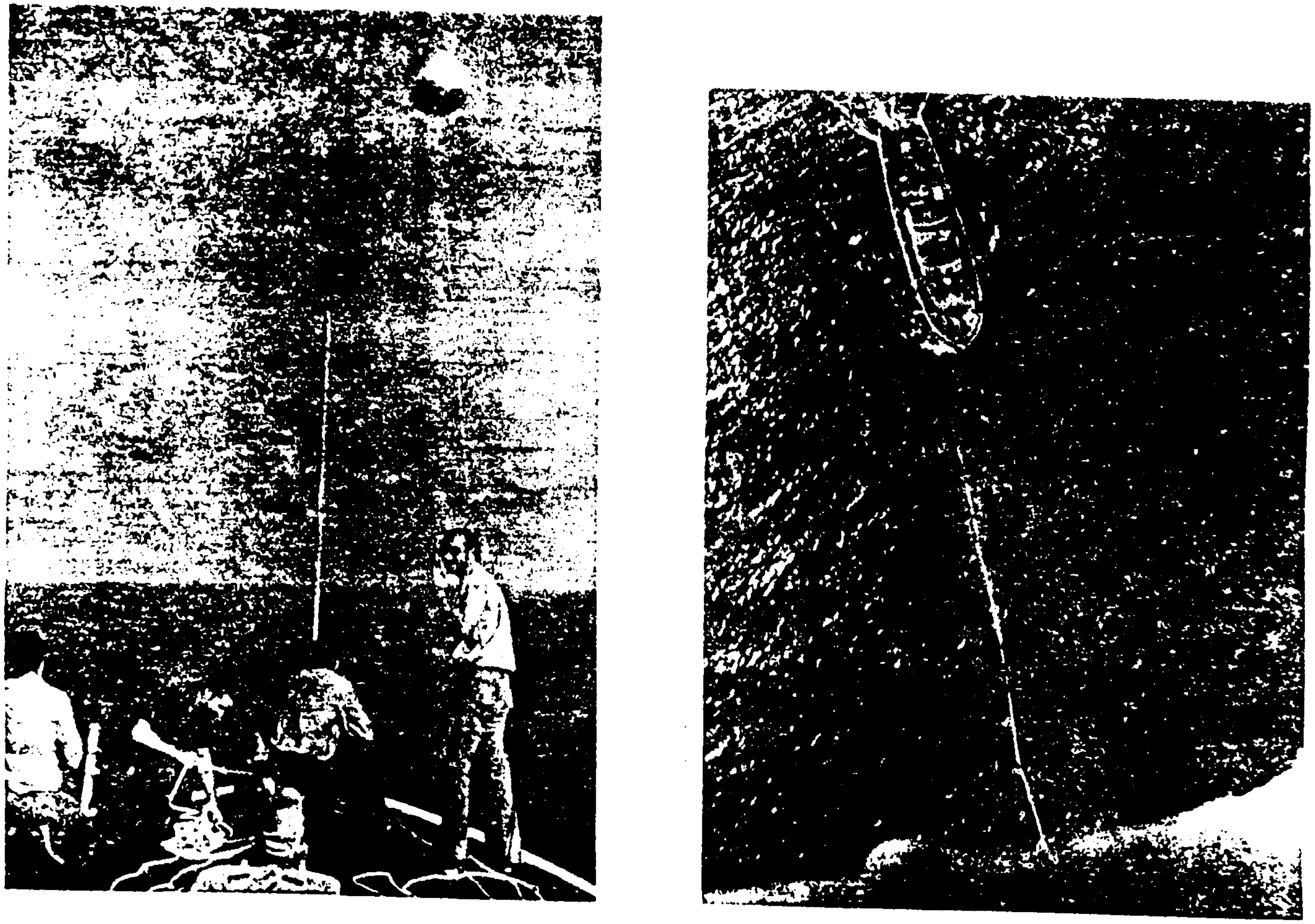

Figure 26. Point Judith Taking Balloon in Tow for Landing Approach

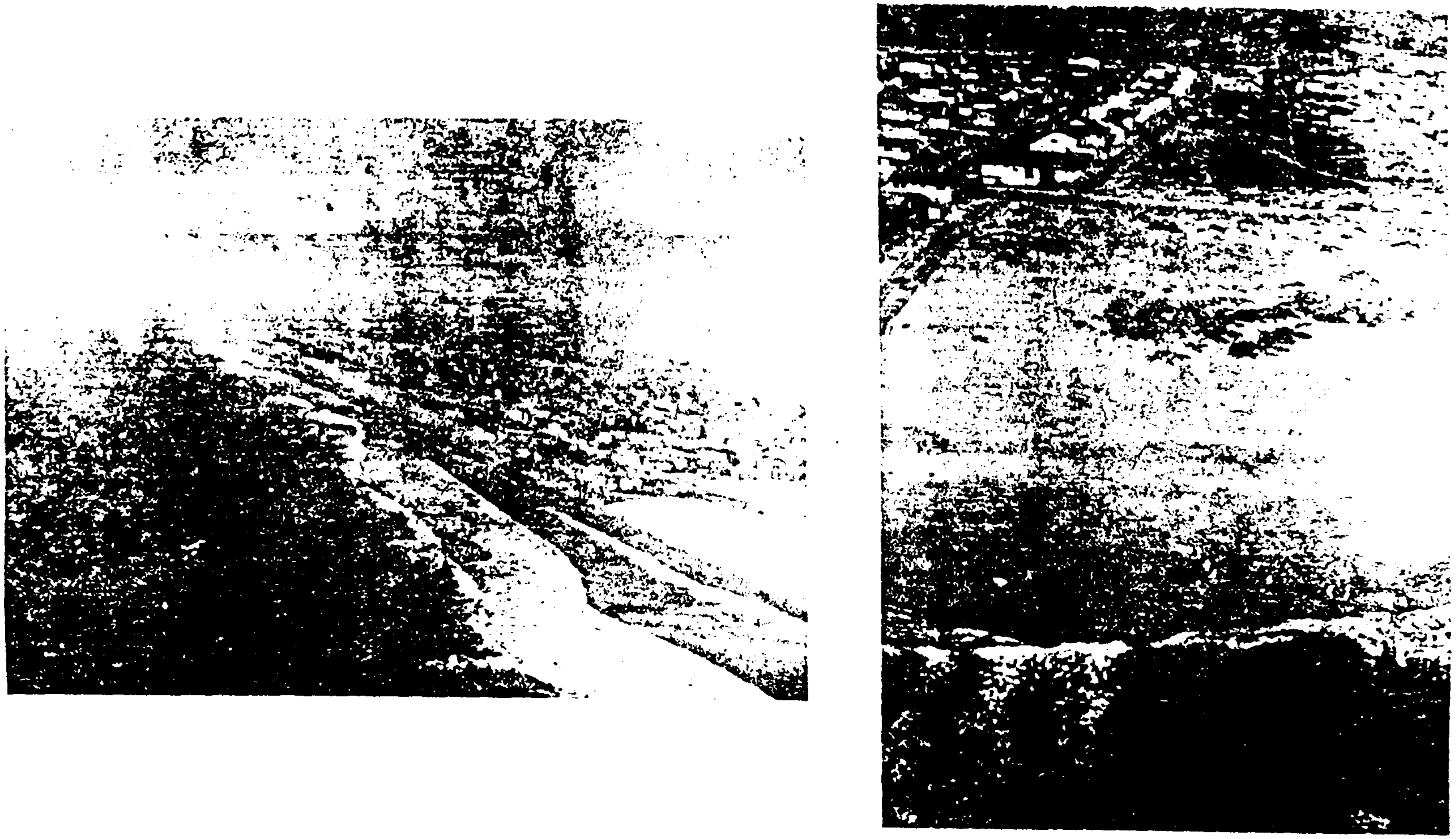

Figure 27. Final Landing Approach as seen from the Balloon

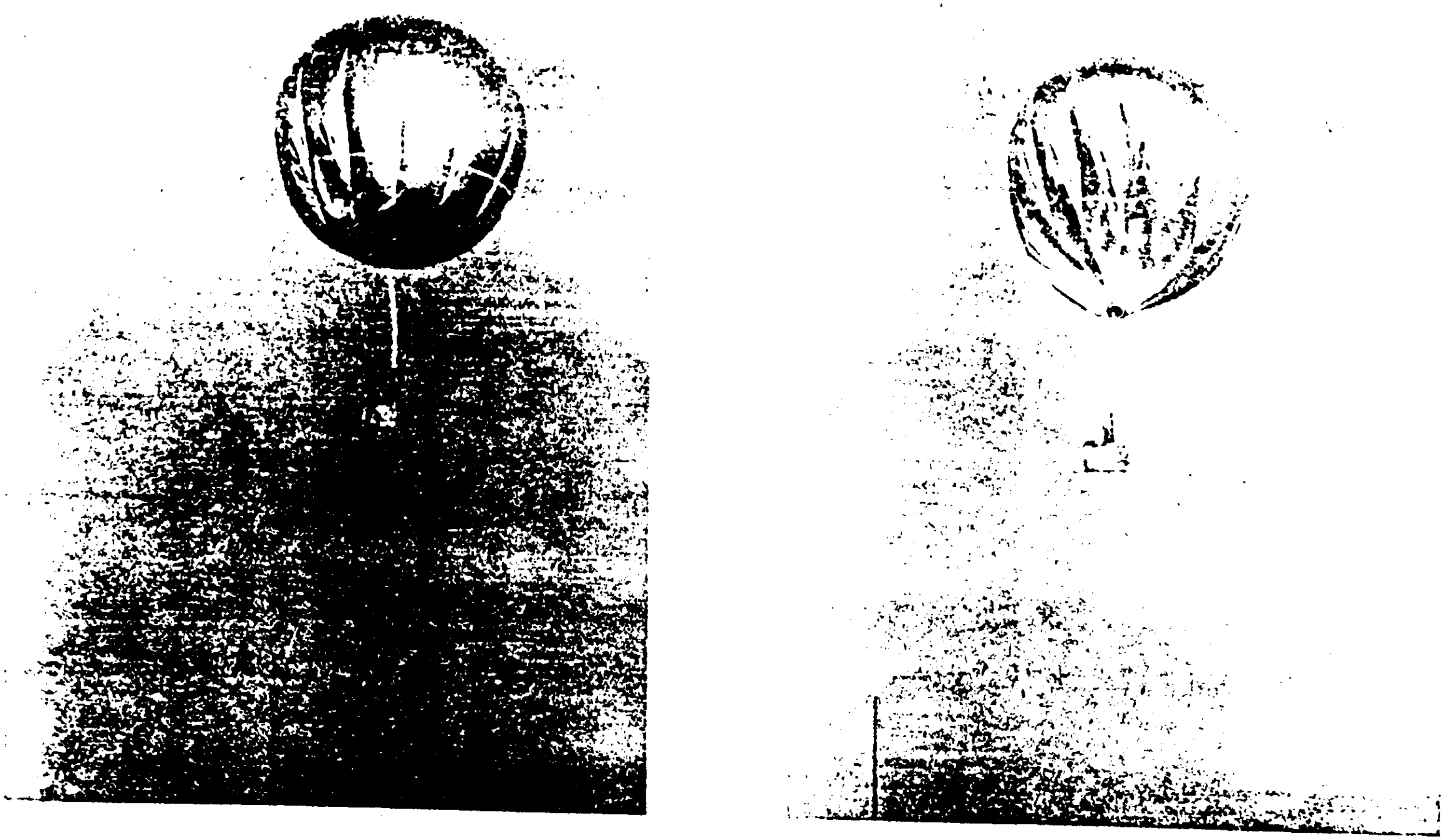

Figure 28. Balloon Deflating Due to Helium Venting by Crew During Final Approach

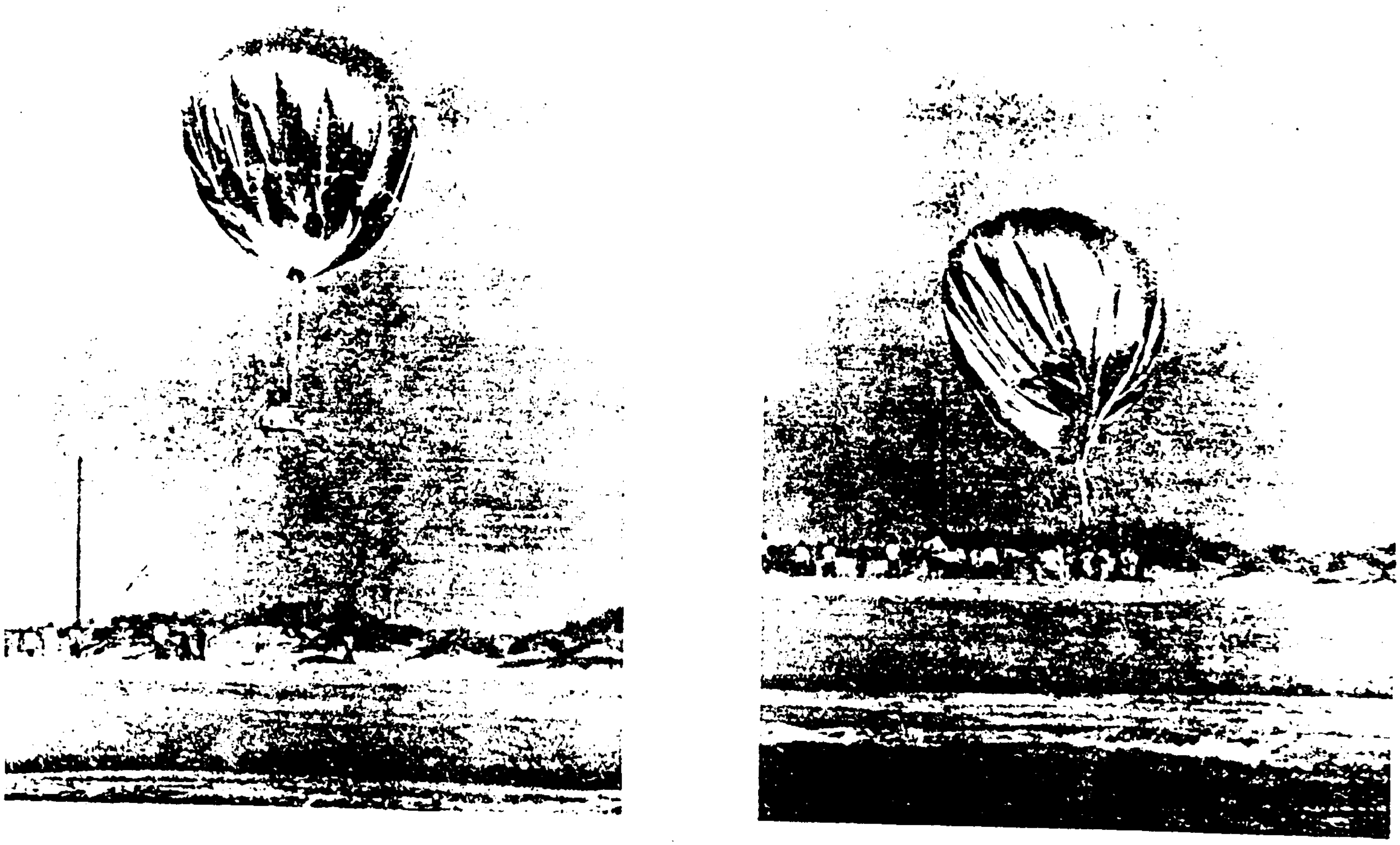

Figure 29. Touchdown at Oxnard Shores

With the landing of the balloon and the release of the tow line, the cutter returned to Santa Barbara, landing the project people at the Coast Guard dock at 1820. By that time the gondola and balloon had been reloaded into their transport vehicles and were on their way home; the gondola returning to the laboratory of the SCAQMD for post flight retreival of data; the balloon to Neushul, Inc., for subsequent inspection and leak testing.

VI. FLIGHT DATA

The flight trajectory is shown in Figure 30, an enlargement of the becalmed area is shown in Figure 31, and a reproduction of the cutter's tracking log is shown in Table 1. Figures 30 and 31 (the same as Figures 1 and 2) are repeated for the convenience of the reader. The onboard data plots are shown in Figures 32 through 35.

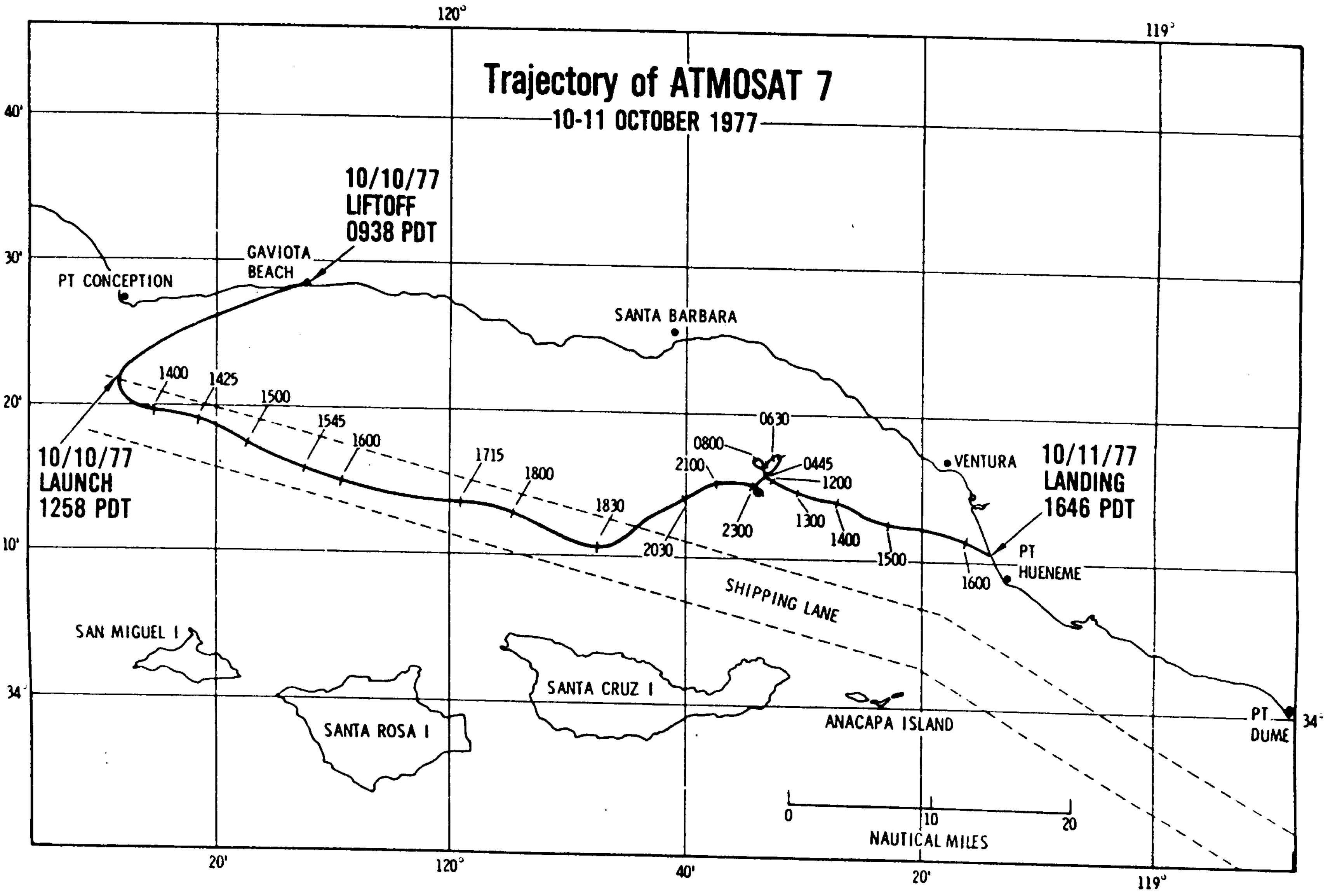

Figure 30. ATMOSAT-7 Flight Trajectory

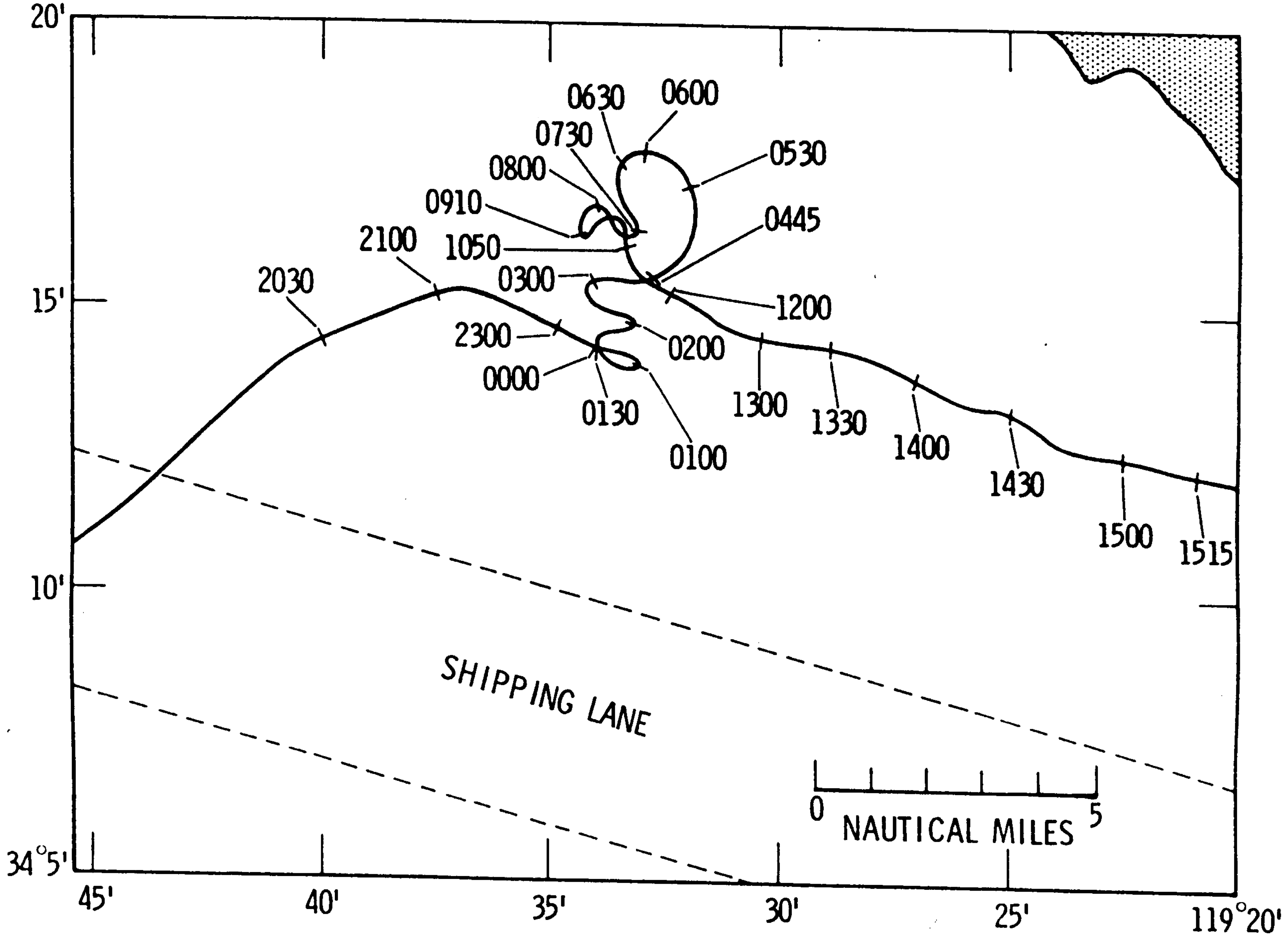

Figure 31. Enlargement of Flight Trajectory During Evening and Early Morning

Table 1. Point Judith Tracking Log

Date	Time, PDT	Position	
		Latitude, N	Longitude, W
10/10/77	1130	34° 24.5'	120° 23.0'
	1145	34° 24.1'	120° 23.7'
	1200	34° 22.9'	120° 26.0'
	1215	34° 22.4'	120° 27.3'
	1230	34° 21.3'	120° 28.6'
	1241	34° 20.9'	120° 30.0'
	1316	34° 20.3'	120° 28.9'
	1331	34° 19.7'	120° 26.7'
	1345	34° 19.6'	120° 25.0'
	1400	34° 19.2'	120° 23.9'
	1425	34° 18.7'	120° 21.6'
	1440	34° 17.6'	120° 19.2'
	1455	34° 17.3'	120° 17.5'
	1515	34° 16.5'	120° 16.2'
	1530	34° 16.4'	120° 16.0'
	1545	34° 15.5'	120° 12.6'
	1600	34° 14.7'	120° 09.5'
	1615	34° 12.4'	120° 07.5'
	1635	No Fix	
	1640	34° 13.3'	120° 07.5'
	1715	34° 13.2'	119° 58.5'
	1730	No Fix	
	1757	34° 12.8'	119° 54.7'
	1820	Bad Fix	
	1830	34° 10.5'	119° 47.2'

Table 1. Point Judith Tracking Log (Continued)

Date	Time, PDT	Position	
		Latitude, N	Longitude, W
10/10/77	1903	No Fix	
	2030	34° 14.5'	119° 40.0'
	2100	34° 15.3'	119° 37.5'
	2225		
	2300	34° 14.7'	119° 34.9'
	2330	34° 14.4'	119° 34.4'
10/11/77	0000	34° 14.3'	119° 34.0'
	0030	34° 14.2'	119° 33.4'
	0100	34° 14.0'	119° 33.2'
	0130	34° 14.3'	119° 34.0'
	0200	34° 14.7'	119° 33.3'
	0230	34° 15.1'	119° 34.1'
	0300	34° 15.5'	119° 34.1'
	0330	34° 15.5'	119° 33.5'
	0400	No Fix	
	0430	No Fix	
	0445	34° 15.5'	119° 33.0'
	0500	34° 15.9'	119° 32.2'
	0530	34° 17.2'	119° 32.0'
	0600	34° 17.8'	119° 33.0'
	0630	34° 17.6'	119° 33.5'
	0700	34° 16.9'	119° 33.4'
	0730	34° 16.4'	119° 33.2'
	0800	34° 16.8'	119° 34.0'
	0835	34° 16.7'	119° 34.2'
	0845	34° 16.7'	119° 34.2'
	0910	34° 16.3'	119° 34.4'
	0945	34° 16.6'	119° 34.0'

Table 1. Point Judith Tracking Log (Continued)

Date	Time, PDT	Position	
		Latitude, N	Longitude, W
10/11/77	1015	34° 16.5'	119° 33.5'
	1050	34° 16.1'	119° 33.5'
	1130	34° 15.6'	119° 33.3'
	1200	34° 15.3'	119° 32.5'
	1230	34° 14.8'	119° 31.6'
	1300	34° 14.5'	119° 30.4'
	1330	34° 14.3'	119° 29.0'
	1350	34° 14.0'	119° 27.7'
	1400	34° 13.8'	119° 27.1'
	1415	34° 13.3'	119° 25.7'
	1430	34° 13.2'	119° 25.0'
	1445	34° 12.8'	119° 24.2'
	1500	34° 12.5'	119° 22.5'
	1515	34° 12.2'	119° 20.9'
	1530	34° 12.0'	119° 19.4'
	1545	34° 11.7'	119° 17.9'
	1600	34° 11.5'	119° 16.5'
	1646	34° 10.6'	119° 14.2'

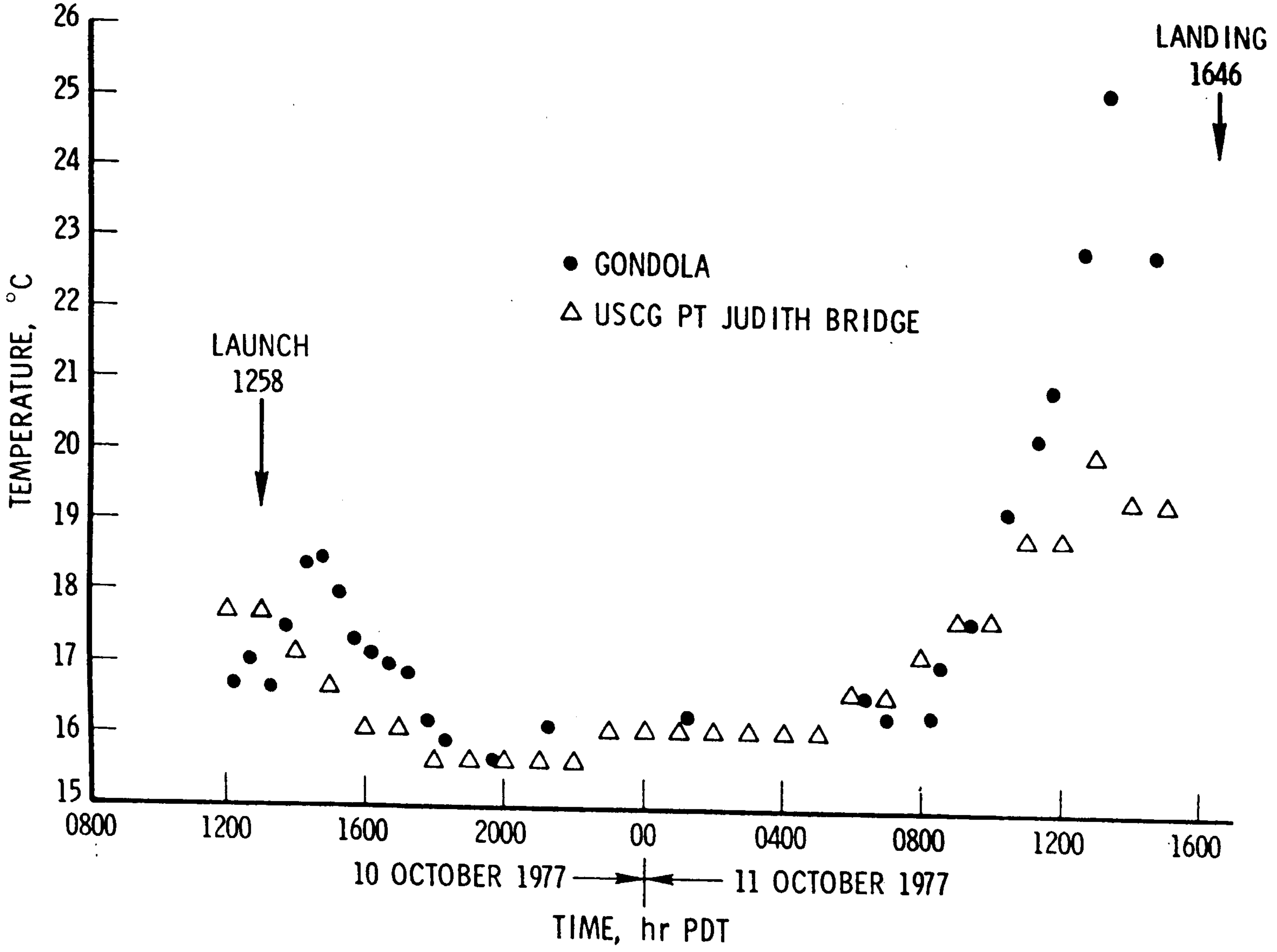

Figure 32. Ambient Temperature

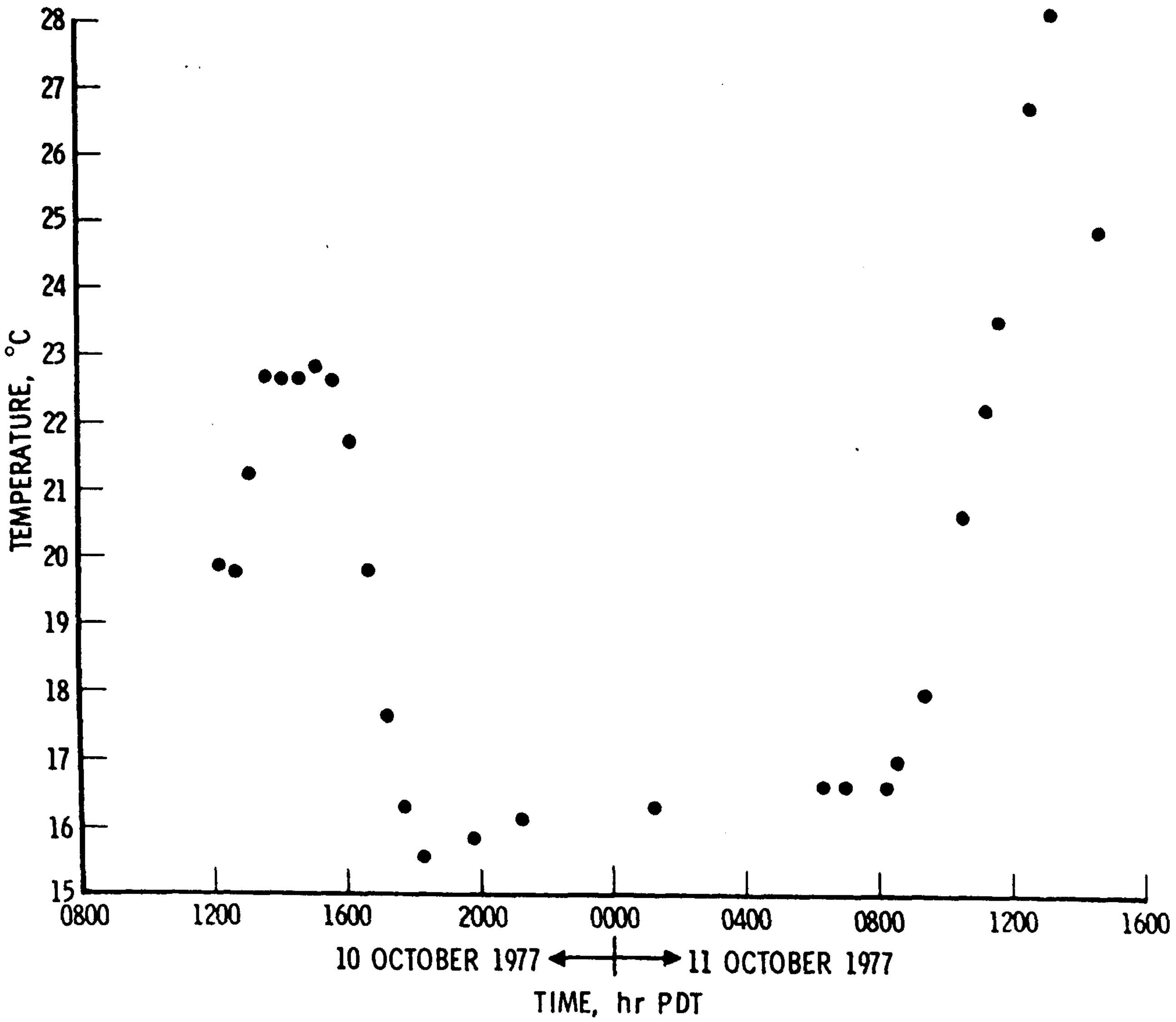

Figure 33. Gas Temperature

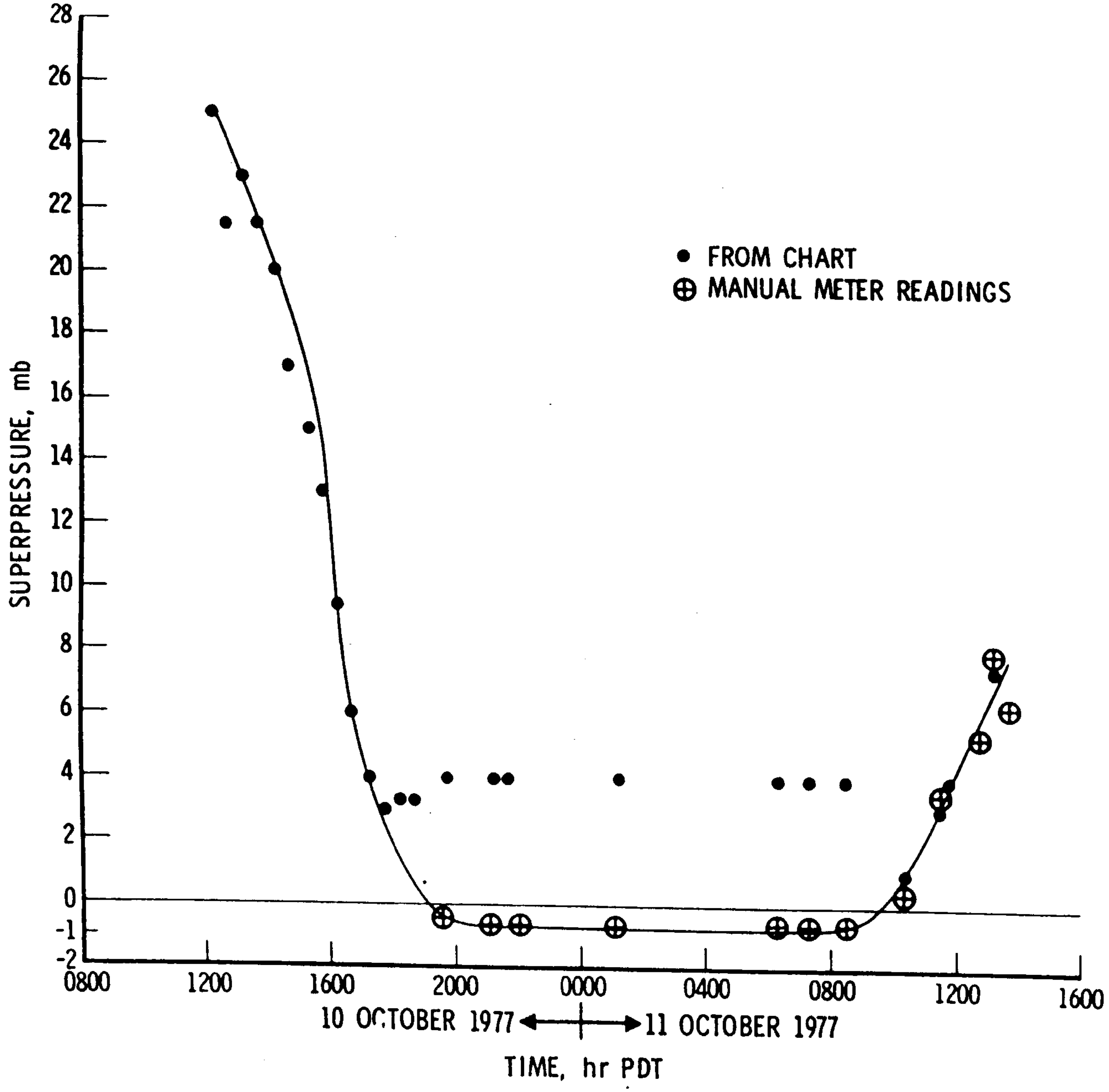

Figure 34. Superpressure

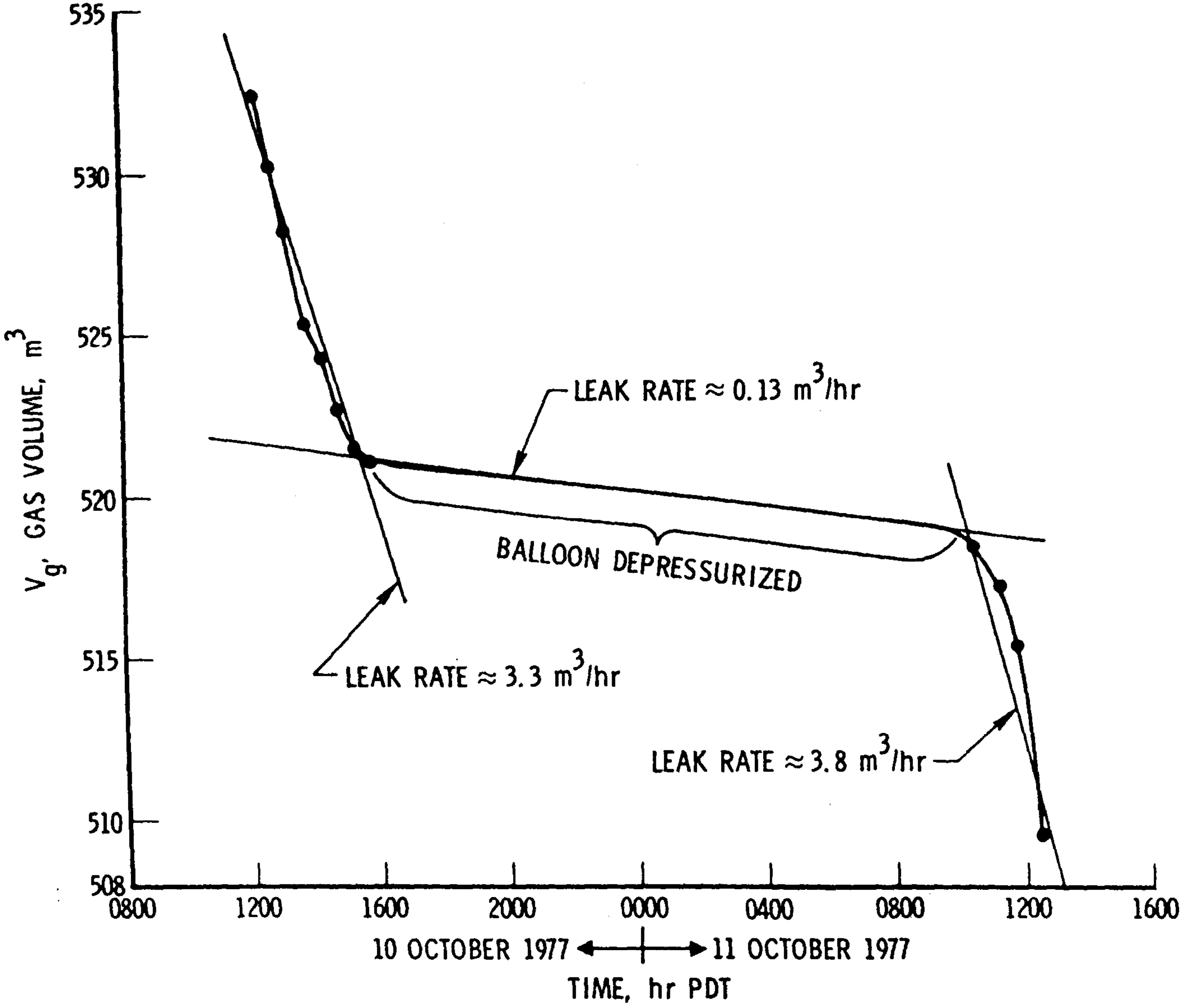

Figure 35. Gas Volume

VII. GUIDE ROPE EVALUATION

To evaluate the effect of having the floating guide rope in the water during the free flight, the following analysis was made. The time of flight in which the error induced by the floating guide rope would be the greatest is the first 5 to 6 hours after launch when the balloon was moving at its maximum observed speed in a southeastward direction in the shipping lane. Subsequently, during the night and early morning hours when the balloon was virtually becalmed, the effect would be negligible. During the final hours of accelerating motion toward Oxnard the effect would be to slightly delay the arrival time on the beach, but would have little effect on the general landfall location.

The worst case period is evaluated by taking the period from 1400 to 1830 (October 10). The hourly log of weather observations taken aboard the Point Judith shows the wind speed to be 8 knots at 305° true from 1300 to 1900 PDT. The positions taken from the cutter's log for those times indicate a great circle distance of 31.5 nmi point-to-point and a distance along the trajectory of 32.0 nmi at 285° true (See Table 1 and Figure 30). This leads to the following comparison:

	Balloon Trajectory	Cutter Wind Observations
Speed (Knots)	7.1	8.0
Direction (True)	285°	305°

The comparison suggests that the floating guide rope did not significantly change the evolution of the balloon's trajectory.

VIII. METEOROLOGICAL ANALYSIS OF ATMOSAT-7 PREPARED BY THE SCAQMD

(Art Davidson)

A. METEOROLOGY

The intention of ATMOSAT-7 was to trace the path of an air mass from the Santa Barbara Channel shipping lanes about 10 miles south of Point Conception to its eventual landfall, on a day characterized by the "marine layer" conditions typical of the period May through October. This period is considered to be the photochemical smog season in Southern California.

The weather during the afternoon of October 9, 1977 (one day prior to launch) was characterized by patchy stratus clouds over the coastal waters from Point Conception to the Mexican Border (see satellite photograph, Figure 36). These clouds increased considerably on the day of launch, October 10, 1977, and decreased significantly the next day (see satellite photographs, Figures 37 and 38).

These changes were tracked by the morning temperature soundings at Los Angeles International Airport (LAX) shown in Figure 39. The inversion base[*] lifted from 1800 ft on October 9 to 2800 ft on October 10, with the increase in onshore flow. The base then descended to 2000 ft on the morning of October 11. Surface wind patterns will be dealt with later in this section.

B. NARRATIVE OF FLIGHT AND RESULTS

After the localized, strong, gusty northerly winds of the previous night and early that morning at Gaviota Beach had subsided, the balloon was inflated with helium and taken in tow by the cutter on October 10, 1977 at 0938.[**] The balloon was then towed out to the launch site and released at

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[*] Under marine layer conditions, the morning inversion base generally coincides with the tops of the stratus clouds.

[**] All times are Pacific Daylight Time and all distances are in statute miles.

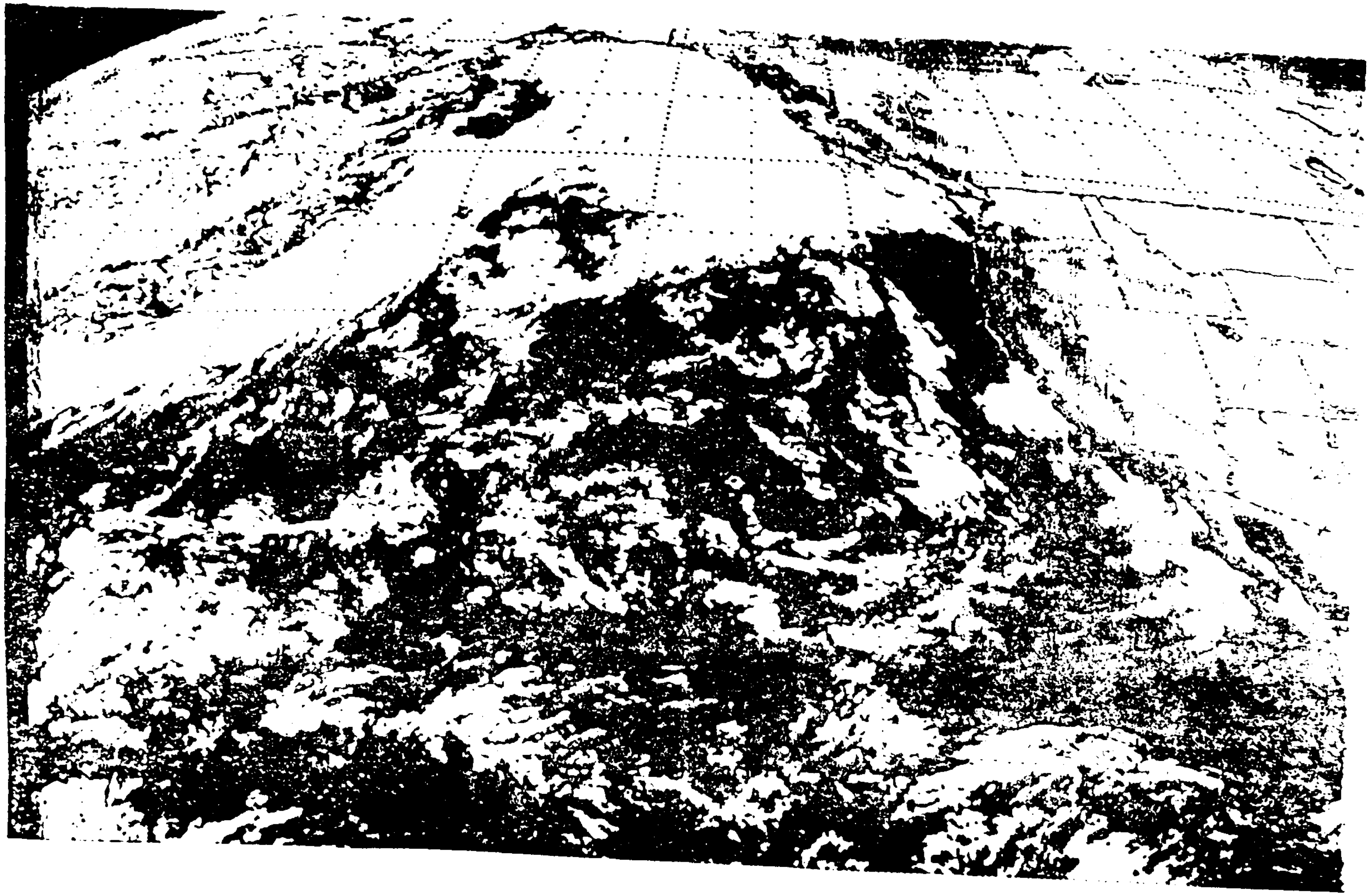


Figure 36. GOES-W Visibility 2 × 2 mi 10/09/77 2115Z (2:15 pm)

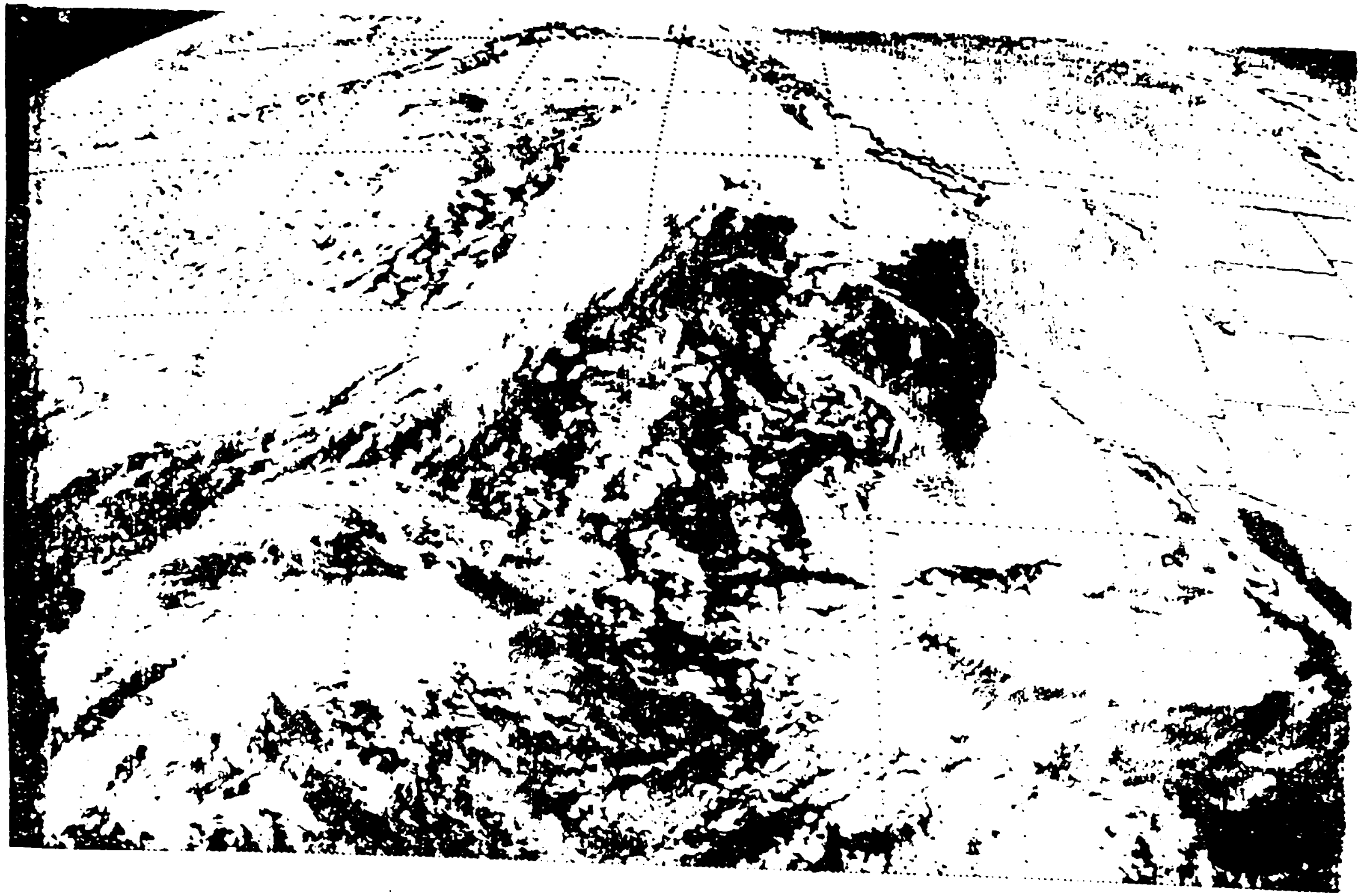


Figure 37. GOES-W Visibility 2 × 2 mi 10/10/77 2115Z ([illegible]:15 pm)

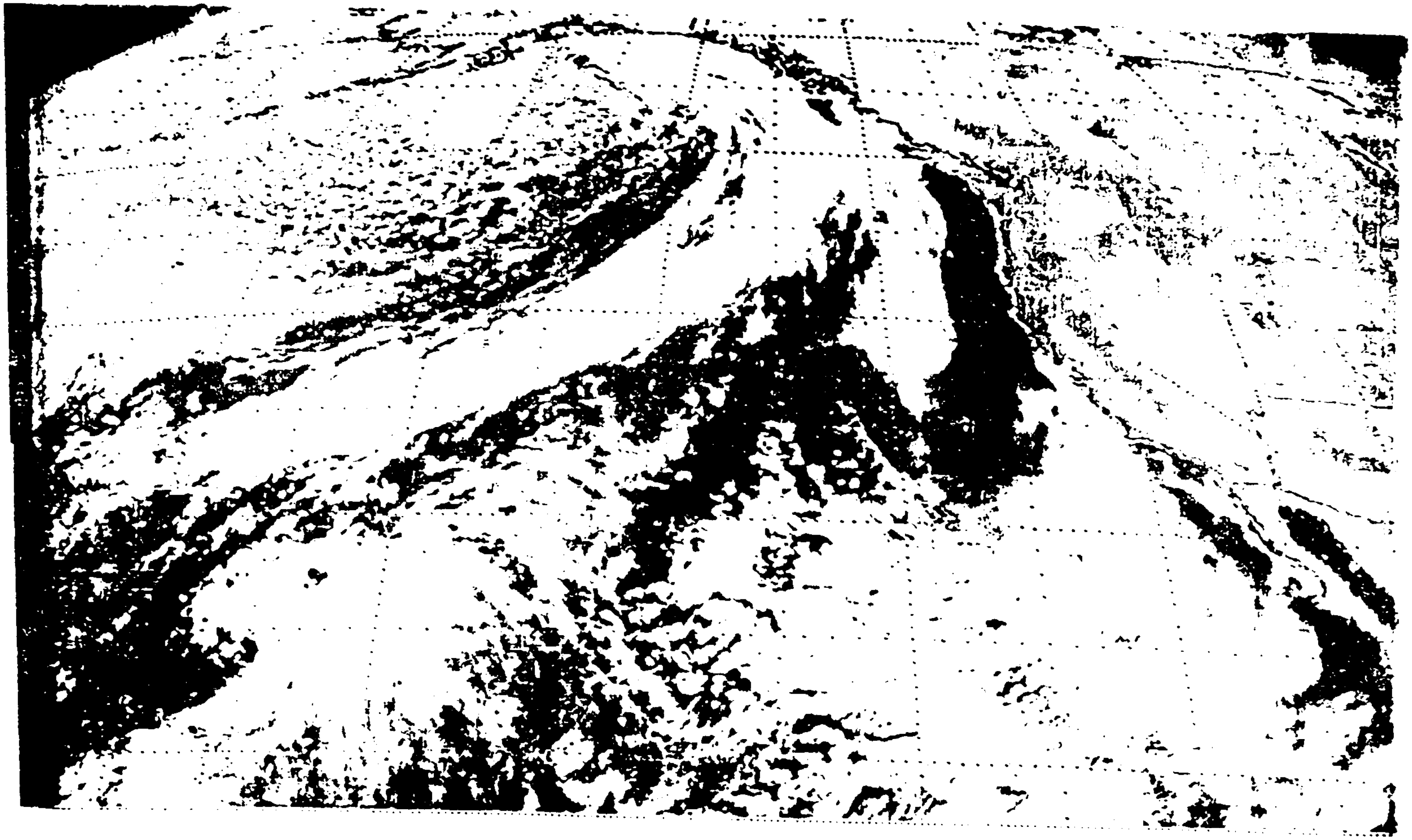


Figure 38. GOES-W Visibility 2 x 2 mi 10/11/77 2115Z (2:15 pm)

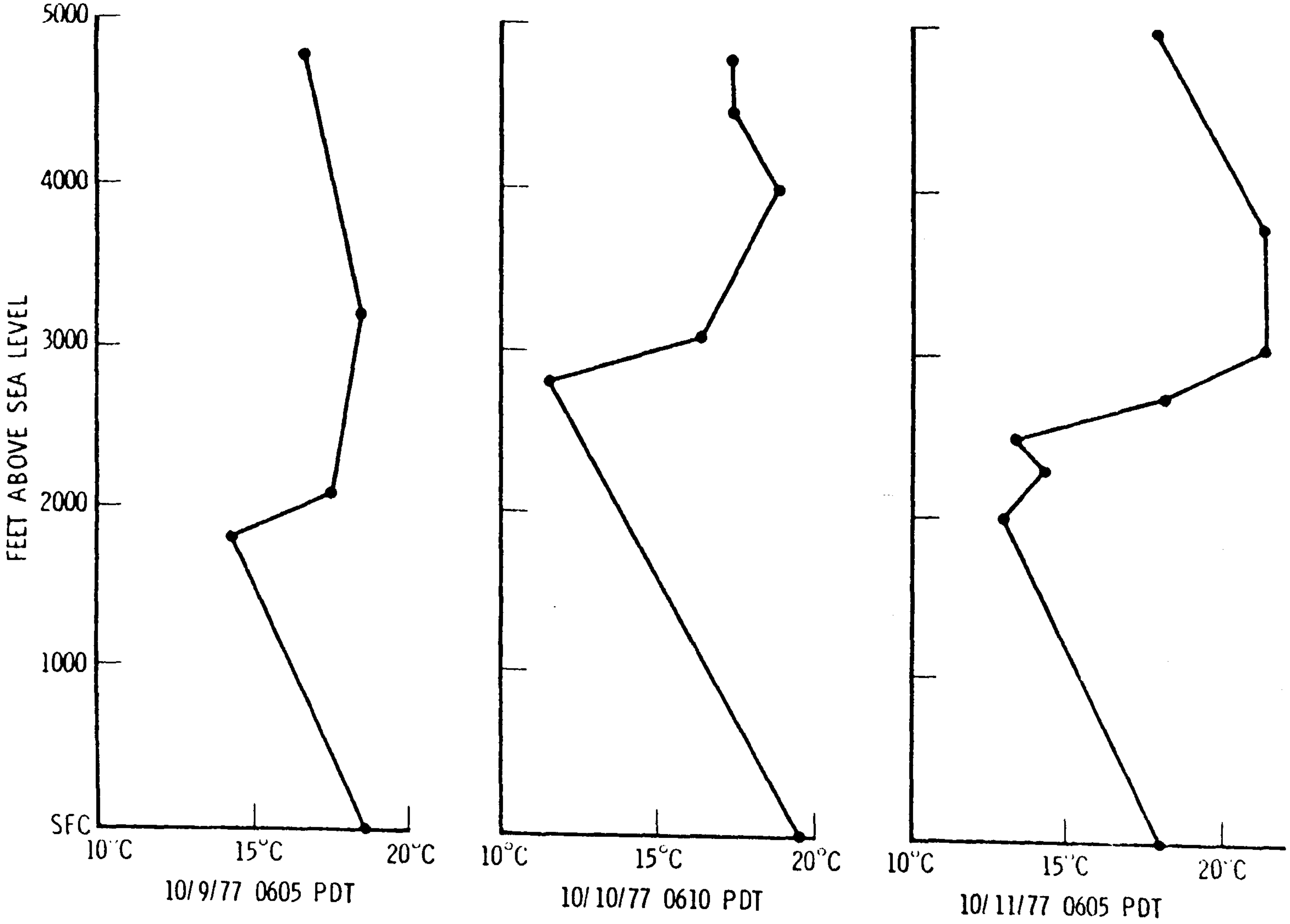


Figure 39. Morning Temperature Soundings at Los Angeles International Airport (LAX)

1258. It moved in an east-southeasterly direction at an average speed of 7.6 miles per hour (mph) until 1800 when it lay about 14 miles southwest of Santa Barbara point. Throughout the flight the balloon maintained an altitude between 200 and 250 feet above the sea, flying below the base of the stratus clouds, which generally ranged between 500 and 900 feet above sea level (ASL).

Shortly before 1900 it became apparent that the balloon was on a course that would intersect with an offshore drilling platform within a period of about 1 hour. At this point, the balloon was taken in tow (from 1903 to 1943) and guided around the obstruction, and then released to move with the prevailing wind again.

From about 2000 on October 10, 1977 until 1200 on October 11, 1977 the balloon stagnated in a small area centered about 10 miles south-southwest of Carpenteria. At this time the developing and strengthening seabreezes moved the balloon toward the east-southeast, reaching just offshore at Oxnard Shores (north of the Channel Islands) at 1550. The cutter then took a loose hold on the balloon tow line and aided it to a guided landing on the beach at Oxnard Shores. The last 2 hours of the flight saw the breakup of the stratus overcast, and by the time the balloon landed at 1646, skies were clear.

C. REPRESENTATIVENESS OF DAYS CHOSEN FOR FLIGHT

Figures 40 and 41 are taken from a U.S. Department of Commerce publication, Technical Paper No. 54, "Meteorological Summaries Pertinent to Atmospheric Transport and Dispersion over Southern California." They show average July and October streamline patterns for the period 1200-1800 PST. Figures 42 and 43 represent the streamline patterns for the midpoint of this period, 1600 PDT on October 10 and 11, respectively. The similarity in the seabreeze flows between the two sets of charts is apparent. Both sets indicate that much (if not most) of the air in the shipping lanes south of Point Conception is destined to move onshore in Santa Barbara or Ventura Counties, outside the South Coast Air Basin.

Source: Technical Paper No. 54, "Meteorological Summaries
Pertinent to Atmospheric Transport and Dispersion
over Southern California", U.S. Department of Commerce

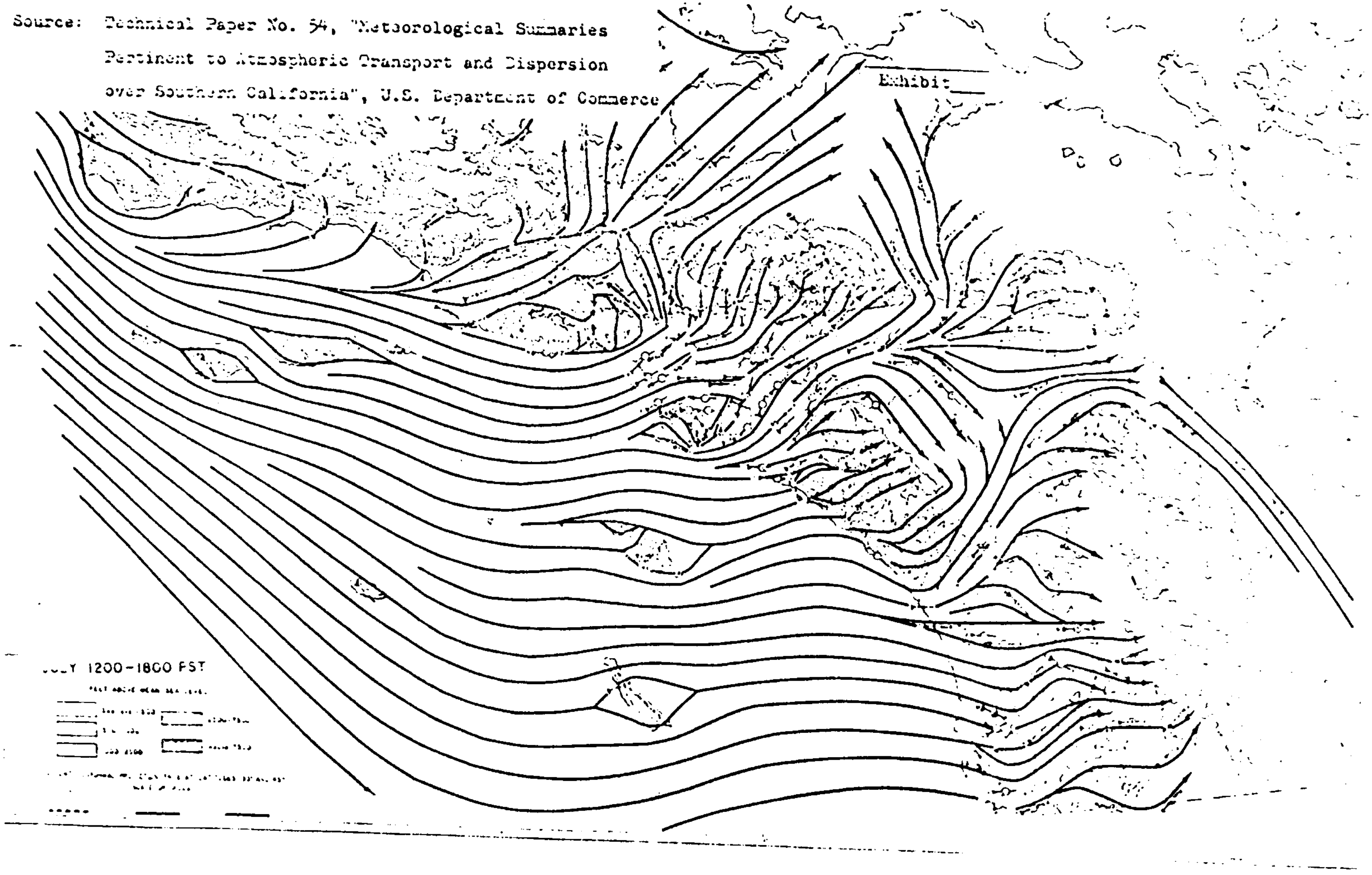


Figure 40. Streamline Chart for July, 1200 to 1800 PST

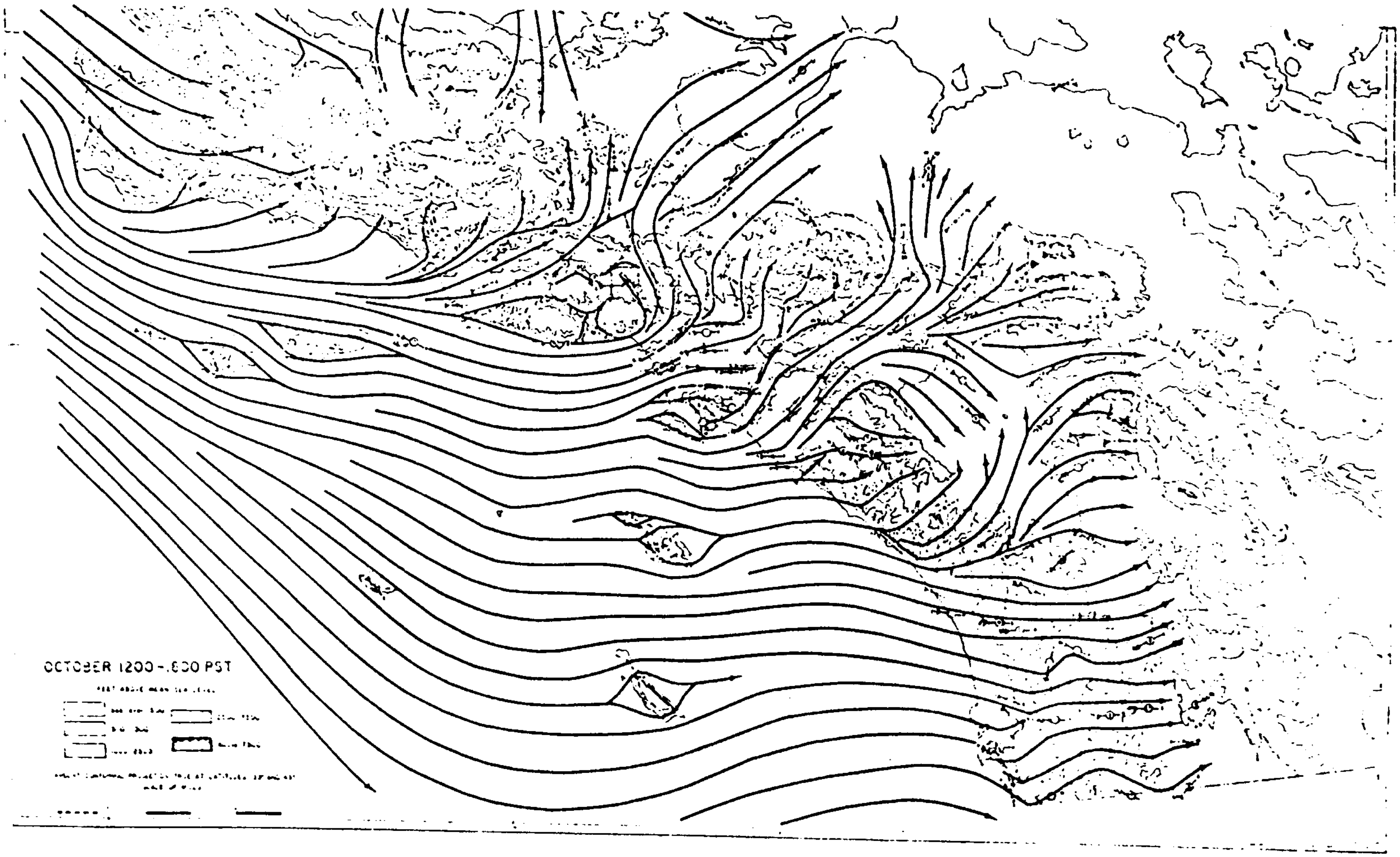


Figure 41. Streamline Chart for October, 1200 to 1800 PST

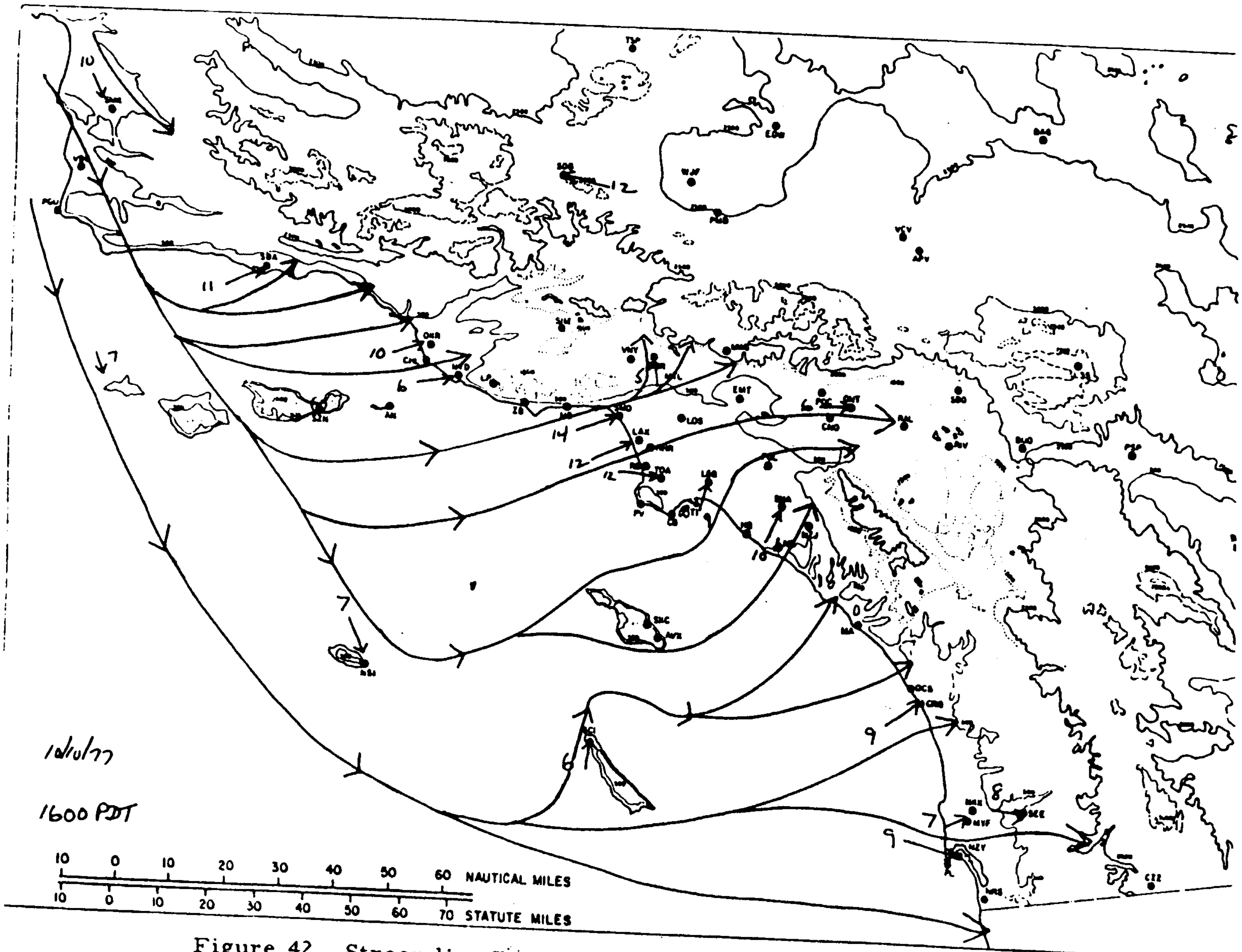

10/10/77
1600 PDT
10 0 10 20 30 40 50 60 NAUTICAL MILES
10 0 10 20 30 40 50 60 70 STATUTE MILES

Figure 42. Streamline Patterns for October 10, 1600 PDT

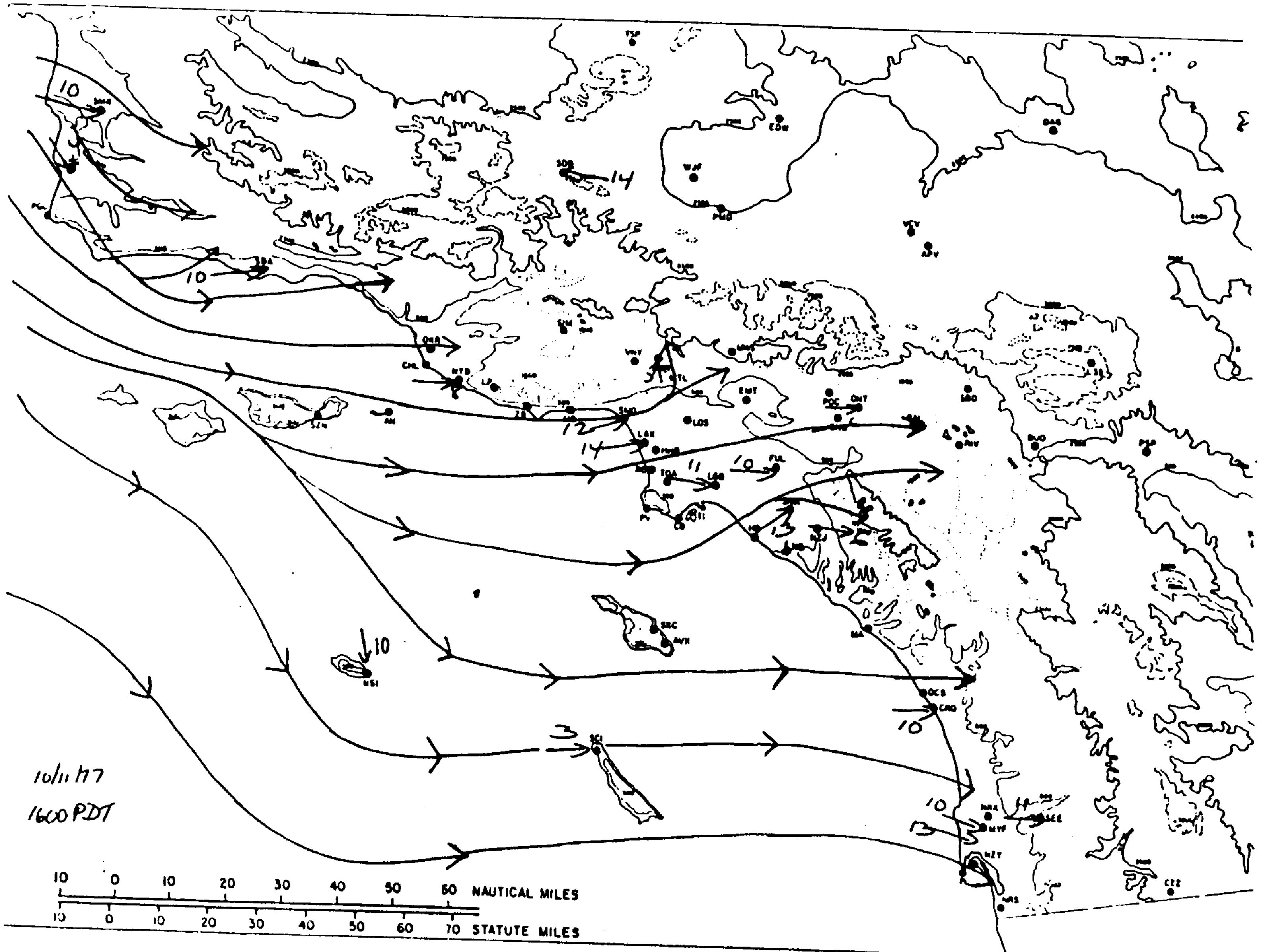


Figure 43. Streamline Patterns for October 11, 1600 PDT

The above is also the trajectory taken by the balloon, as shown in Figure 1. The stagnation experienced by the balloon from the late night of October 10 through the late morning hours of October 11 also is borne out by Figures 44 and 45 showing an area of undefined (light) winds just seaward of the nighttime land-breeze, along the path of the balloon.

D. CONCLUSIONS AND FURTHER SUPPORTING EVIDENCE

Based on the flight of Atmosat-7 and the average wind streamlines of Technical Paper No. 54 cited above, the emissions in the shipping lanes just south of Point Conception are at least as likely to move onshore in Santa Barbara or Ventura Counties. Figures 40 and 41 do show, however, that part of the emissions from eastern Ventura County could move into the western portion of the South Coast Air Basin.

For the purpose of stable flight the balloon trailed a drag line of several hundred feet in length, the bottom 50 ft floating in the sea. The effect of any drag would be to slow the balloon down relative to the prevailing wind, and lengthen the amount of time taken for the balloon to move onshore with the seabreezes. At this time there is no evidence to indicate that without the drag the balloon would have moved onshore in the South Coast Air Basin, as opposed to its actual landfall in Ventura County.

Supporting evidence to the above conclusion can be found in Figure 46, which was presented in the prepared testimony of Mr. Spencer Duckworth of the Air Resources Board, presented before the South Coast Air Quality Management District's public hearing on the SOHIO project on September 28, 1977.

Of the two theoretical trajectories drawn to show the fate of emissions in the shipping lanes between Oxnard and Point Conception, both make landfall well north of the South Coast Air Basin.

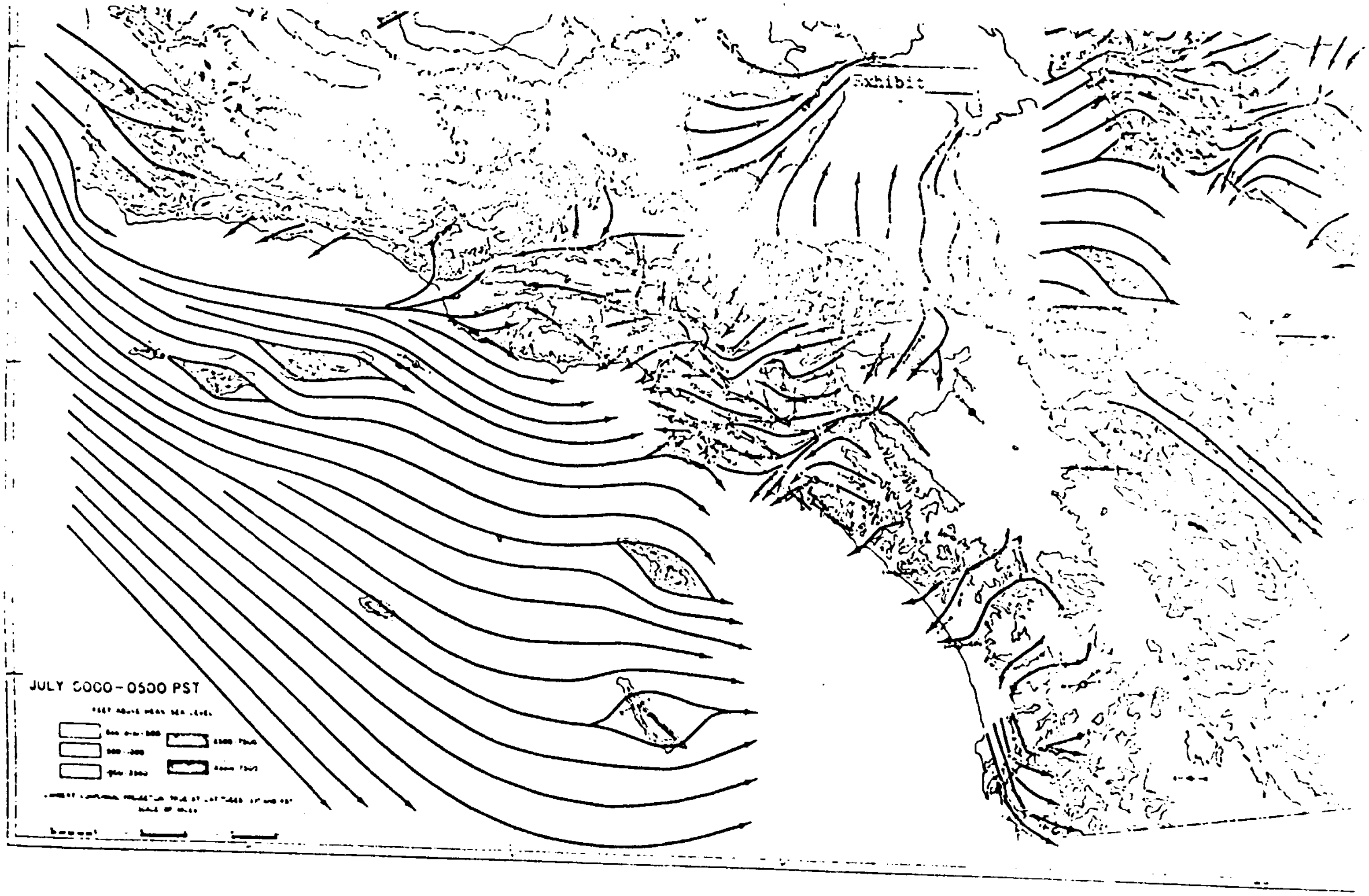
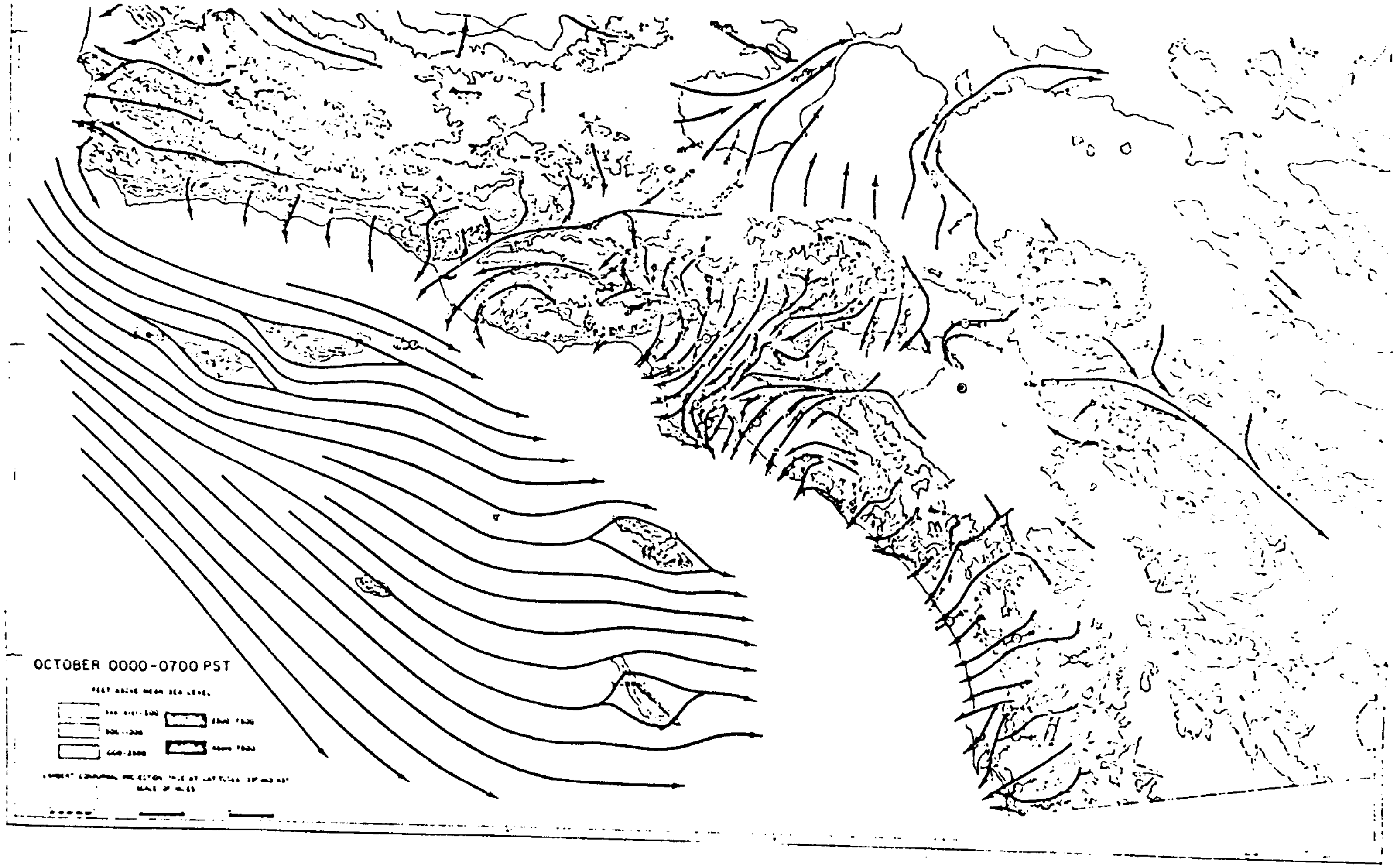


Figure 44. Streamline Chart for July, 0000 to 0500 PST



Fig' re 45. Streamline Chart for October, 0000 to 0700 PST

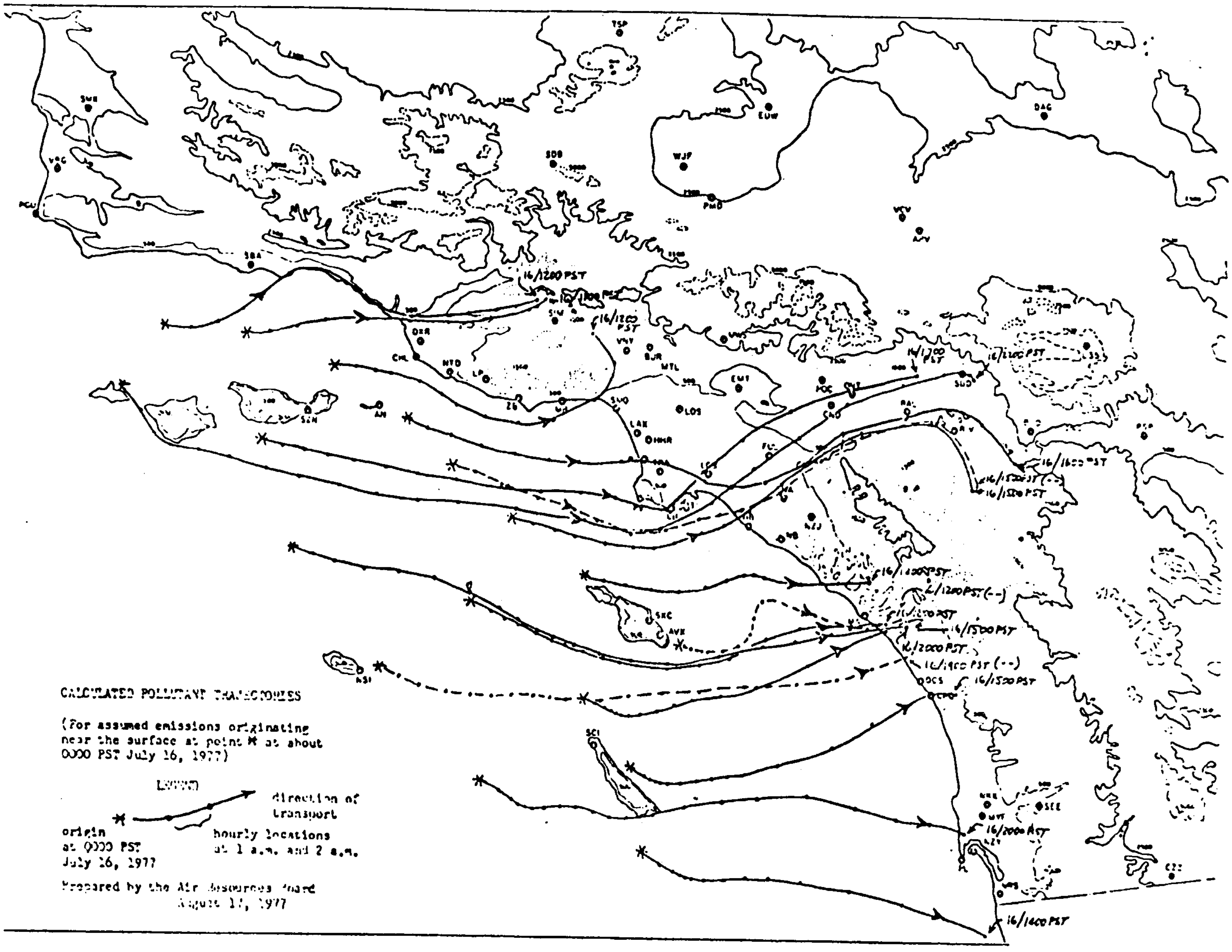


Figure 46. Calculated Pollutant Trajectories

From all the readily available evidence then, it is reasonable to assume that a large proportion of emissions in the shipping lanes from Point Conception to about Oxnard will move onshore in Santa Barbara and Ventura Counties.

APPENDIX A

PROGRAM DEFINITION

During the week of September 26 the experimental requirements and details of the flight plan were worked out in a series of meetings attended by representatives of:

- The Port of Long Beach
- The California Air Resources Board (ARB)
- The South Coast Air Quality Management District (SCAQMD)
- The U.S. Coast Guard
- The County of Los Angeles Communications Department
- The California Public Utilities Commission
- The Aerospace Corporation

As a result of these meetings, a protocol was drafted by the SCAQMD and is presented on the following pages.

PROTOCOL FOR THE FLIGHT OF ATMOSAT-7

October 6, 1977

I. General Description of the Joint Project Involving the Port of Long Beach, Aerospace Corporation, South Coast Air Quality Management District (SCAQMD) and the U.S. Coast Guard

II. Major Decision Points and Associated Actions

III. Listing of Personnel and Responsibilities

IV. **Flow Chart of Atmosat-7 Decisions and Associated Actions to Launch**

I. General Description of the Proposed Flight of Atmosat 7; A Joint Project Involving the Port of Long Beach, Aerospace Corporation, SCAQMD and the U.S. Coast Guard

The objective of the Atmosat 7 series is to trace the trajectory of an airmass originating in the shipping lanes about 10 miles south of Point Conception, to determine how likely it is that such an airmass will move onshore anywhere in the South Coast Air Basin.

To carry out this investigation, the Aerospace Corporation's super-pressure helium balloon with a crew of two will be released during the late morning about 10 miles south of Point Conception, after being towed into place from Santa Barbara Harbor by a U.S. Coast Guard cutter. The cutter will then act as a "chase" craft, following about $\frac{1}{2}$ mile behind the balloon as the balloon moves downwind at an elevation of about 300-500 feet over the water. The cutter will take navigational fixes and record its position every 15 minutes, in addition to continuously measuring SO_2 concentration during the exercise.

Under the desired summer-like, marine layer weather conditions, the balloon is expected to move toward the east-southeast at about 8-15 miles per hour, but may show a change to the east-northeast toward Santa Barbara or Ventura Counties after the first 2 hours of the flight. If this turns out to be the case, the balloon will be recovered before it moves onshore, and will be brought back to the launch area south of Point Conception for another release as weather conditions dictate.

If the balloon travels to the South Coast Air Basin, the crew will bring it down onshore, with an Aerospace Corporation truck acting as chase vehicle, and providing support for the landing. The U.S. Coast Guard cutter will then return to port at Long Beach.

II. Major Decision Points and Associated Actions

Assuming that all equipment is in order and that all personnel are ready to go, the initial decisions will be meteorological in nature and are as follows:

(a) Daily 11 AM SCAQMD Smog Forecast for the Following Day

If favorable* conditions are predicted by the duty forecaster, then Ralph Keith and Art Davidson are to be notified. With their joint concurrence, a provisional go forecast will be released, and District, Aerospace, Port of Long Beach and U.S. Coast Guard principals will be notified (see attached flow chart).

(b) 4 PM Forecast Update (if 11 AM forecast was go)

After analyzing the latest meteorological data, Keith, Davidson and the duty forecaster will determine if conditions are still go and notify all principals of their decision. If still go, the U.S. Coast Guard cutter will prepare to depart port, planning for an arrival at Santa Barbara Harbor no later than 4 AM local time the next day. Aerospace Corporation, District and any Port of Long Beach personnel needed for the operation will be at the Santa Barbara Harbor by 4 AM local time, with the balloon and gondola hooked up and ready for inflation by the helium truck.

(c) 5 AM Launch Day Forecast Update

Davidson will check the latest meteorological conditions. If conditions are still go, he will advise that balloon inflation commence.

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*(weather over the coastal waters from Point Conception to the Mexican border)

- marine layer conditions, with ceiling ≥ 800 feet and visibility 2 miles or greater
- light winds (5 knots or less) at Santa Barbara Harbor during period 5 AM-8 AM, local time
- prevailing northwest winds in Point Arguello and Point Conception areas, afternoon onshore flow along the coast from Santa Barbara to the South Coast Air Basin
- no winds greater than 20 knots on the shipping lanes between Point Conception and the South Coast Air Basin
- no rain, but intermittent drizzle permissible
- no broadscale or Catalina eddies
- no Santa Anas or strong offshore flows

(d) 7 AM of Launch Day

The balloon should be fully inflated and checked out by 7 AM. At this time, upon concurrence of the balloon crew, commander of the U.S Coast Guard cutter, Port of Long Beach representative and District representatives, the balloon will be towed out to the launch area (about 10 miles south of Point Conception) for release by late morning.

III. List of Personnel and Responsibilities

(a) Scottie McGregor and his designated assistants -- organization and supervision of a communications center at the Metro Zone (434 So. San Pedro St., Los Angeles 90013); liaison with Dick Bachuber of L. A. County Communications Department; keeping record of reported positions of the cutter and balloon; acting as communications relay as necessary; handling media requests for information on progress of flight.

(b) Irv Cherniak (on cutter) -- mounting the SO_2 monitoring device aboard the cutter and monitoring its operation; assisting in the mounting of equipment aboard the gondola; keeping a detailed record of the balloon's trajectory.

(c) Art Davidson (on cutter), Ralph Keith (Headquarters) and District Forecaster (Headquarters) -- overall technical direction of flight; selection of launch day and time; advice to crew and control centeron predicted balloon trajectories, optimum flight levels and choice of landing site; analysis of flight data.

(d) Dr. Tom Heinsheimer, Peter Neushul and Aerospace Corporation -- preparation and piloting of balloon; clearance from civil and military aviation authorities; monitoring of on-board instrumentation; photography; analysis of flight data.

(e) David Blakeman of Aerospace Corporation (on cutter) -- inflation and launch of balloon; tracking and recovery of balloon and crew, provision of a "chase" truck to support balloon for overland trajectory and landing.

(f) Leland R. Hill, Port of Long Beach -- liaison of the Aerospace Corporation, District and U.S. Coast Guard with the Port of Long Beach authorities; advice during the planning and conducting of the flights.

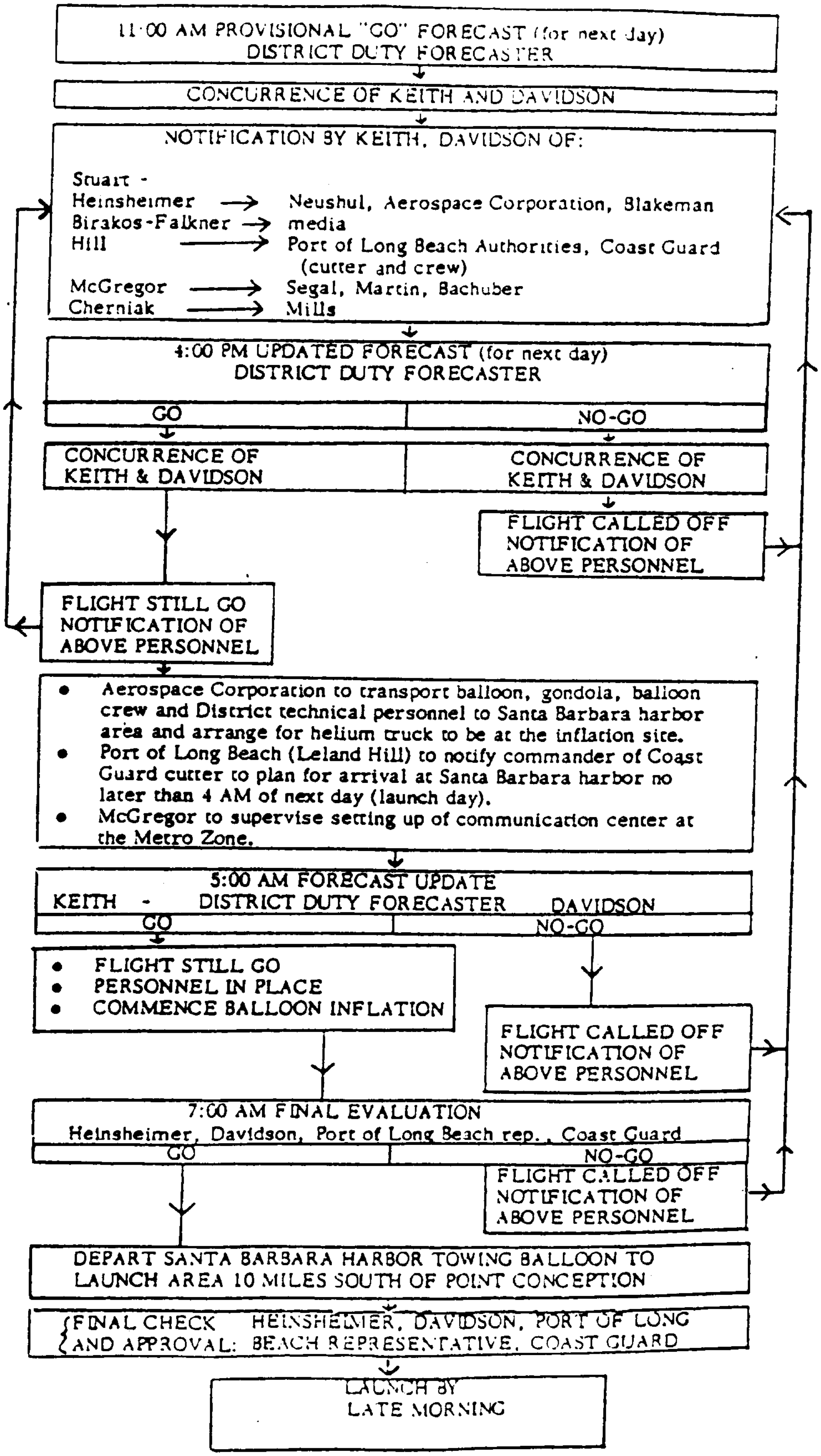
(g) Jim Birakos and Bill Falkner of District, and Port of Long Beach media representative -- liaision with media.

(h) Julian Foon, Metro Zone Data Reduction Group -- reduction of flight data

Before any balloon launch, there must be joint concurrence of the following parties:

1. Balloon crew - Tom Heinsheimer and Pete Neushul
2. Commander of the U.S. Coast Guard cutter
3. Art Davidson - technical director
4. Leland Hill, or other Port of Long Beach representatives

ATMOSAT-7 DECISIONS AND ASSOCIATED ACTIONS TO LAUNCH
ALL TIMES ARE LOCAL



11:00 AM PROVISIONAL "GO" FORECAST (for next day)
DISTRICT DUTY FORECASTER

CONCURRENCE OF KEITH AND DAVIDSON

NOTIFICATION BY KEITH, DAVIDSON OF:

Stuart - Heinsheimer →	Neushul, Aerospace Corporation, Blakeman
Birakos-Falkner →	media
Hill →	Port of Long Beach Authorities, Coast Guard (cutter and crew)
McGregor →	Segal, Martin, Bachuber
Cherniak →	Mills

4:00 PM UPDATED FORECAST (for next day)
DISTRICT DUTY FORECASTER

CONCURRENCE OF KEITH & DAVIDSON

CONCURRENCE OF KEITH & DAVIDSON

FLIGHT CALLED OFF
NOTIFICATION OF
ABOVE PERSONNEL

FLIGHT STILL GO
NOTIFICATION OF
ABOVE PERSONNEL

- Aerospace Corporation to transport balloon, gondola, balloon crew and District technical personnel to Santa Barbara harbor area and arrange for helium truck to be at the inflation site.
- Port of Long Beach (Leland Hill) to notify commander of Coast Guard cutter to plan for arrival at Santa Barbara harbor no later than 4 AM of next day (launch day).
- McGregor to supervise setting up of communication center at the Metro Zone.

5:00 AM FORECAST UPDATE
KEITH - DISTRICT DUTY FORECASTER DAVIDSON

- FLIGHT STILL GO
- PERSONNEL IN PLACE
- COMMENCE BALLOON INFLATION

FLIGHT CALLED OFF
NOTIFICATION OF
ABOVE PERSONNEL

7:00 AM FINAL EVALUATION
Heinsheimer, Davidson, Port of Long Beach rep., Coast Guard

FLIGHT CALLED OFF
NOTIFICATION OF
ABOVE PERSONNEL

DEPART SANTA BARBARA HARBOR TOWING BALLOON TO LAUNCH AREA 10 MILES SOUTH OF POINT CONCEPTION

FINAL CHECK AND APPROVAL: HEINSHEIMER, DAVIDSON, PORT OF LONG BEACH REPRESENTATIVE, COAST GUARD

LAUNCH BY
LATE MORNING

APPENDIX B

DESCRIPTION OF GONDOLA EQUIPMENT

A Hewlett Packard 755A Recorder was used to record voltages versus time, receiving the information from the commutator. Directly below the recorder was the Power Distribution Box, a box that was built by the Air Quality Management District. There are 14 and 28 volts current gauges reading zero to 3 amps each. Directly below the Power Distribution Box are the Lithium batteries. They are Mallory Duracell Lithium Batteries SS# 305039, 14.9 volt nominal, each consisting of 10 lithium cells inside each box, 5 cells in series and two 5-cell series sticks in parallel, each of the series sticks being protected by fuses to prevent overloads, and diodes to prevent any back current when they are put in parallel. Next to the batteries is the commutator and single conditioner box, to which all the signals from all the transducers come and from which the signal to the recorder is sent. There are two switches at the top left of the box; a switch for the lamps that illuminate a vertical row of green lights to indicate to the crew what position the commutator is on, and a switch for the selector that turns the commutator on or off. When "On" it will ripple through all of the 11 parameters in 120 seconds; "Off" it will remain at one parameter. On top of the box are two instruments; the superpressure transducer hooked up to the balloon pressure and giving an electrical output to the commutator system for superpressure, and the absolute pressure transducer giving pressure altitude in the same way. The parameters coming out of the commutator for Flight 7 are as follows:

1. 28 volt supply voltage
2. 14 volt supply voltage
3. Radar altimeter
4. Blank

5. Blank
6. Pressure altimeter
7. Balloon superpressure
8. Radar altimeter
9. Blank
10. Selected temperature
11. Ambient temperature

The selected temperature refers to whatever temperature is set on the YSI Model 42SC Telethermometer, an automatic electronic thermometer that by dialing in the proper temperature thermister indicates the temperature seen by that thermister, and the ambient refers to the temperature sensed by the ambient temperature assembly that was hung outboard during the flight. The recording sequence is shown in Figure 47.

The radio box contained the King KX 145 720-channel VHF com nav system with the omni head, a King KT76TSO four digit radar transponder, a Ball variometer with two settings, 300 feet per minute and 1500 feet per minute full scale, and the standard pressure altimeter. All of this was powered by two 14-volt Mallory batteries. The Winter Barograph SS# 56911 full scale at four kilometers making one turn in 10 hours was the same barograph flown on previous flights. The SBE all channel marine VHF transceiver was used to provide marine band communications.

Also on board was the superpressure assembly housing a Magnahelic pressure transducer measuring 0-50 centimeters of water pressure that shows the balloon superpressure. Directly below the superpressure assembly was the alarm control which, in case of either a high pressure or a low pressure warning, gives a visible and audible alarm. Next, the radar altitude control box for the Bonzer Radar Altimeter consisting of a dial that can be read out from 40 to 2500 feet and an alarm box with both a light and a sound alarm activated in case the ship descends below a preset altitude. The gondola also contained a Rustrak Strip Chart Recorder, which is a dual channel strip chart that measured radar altitude continuously on one channel and pressure altitude on the other channel (without going through the commutator).

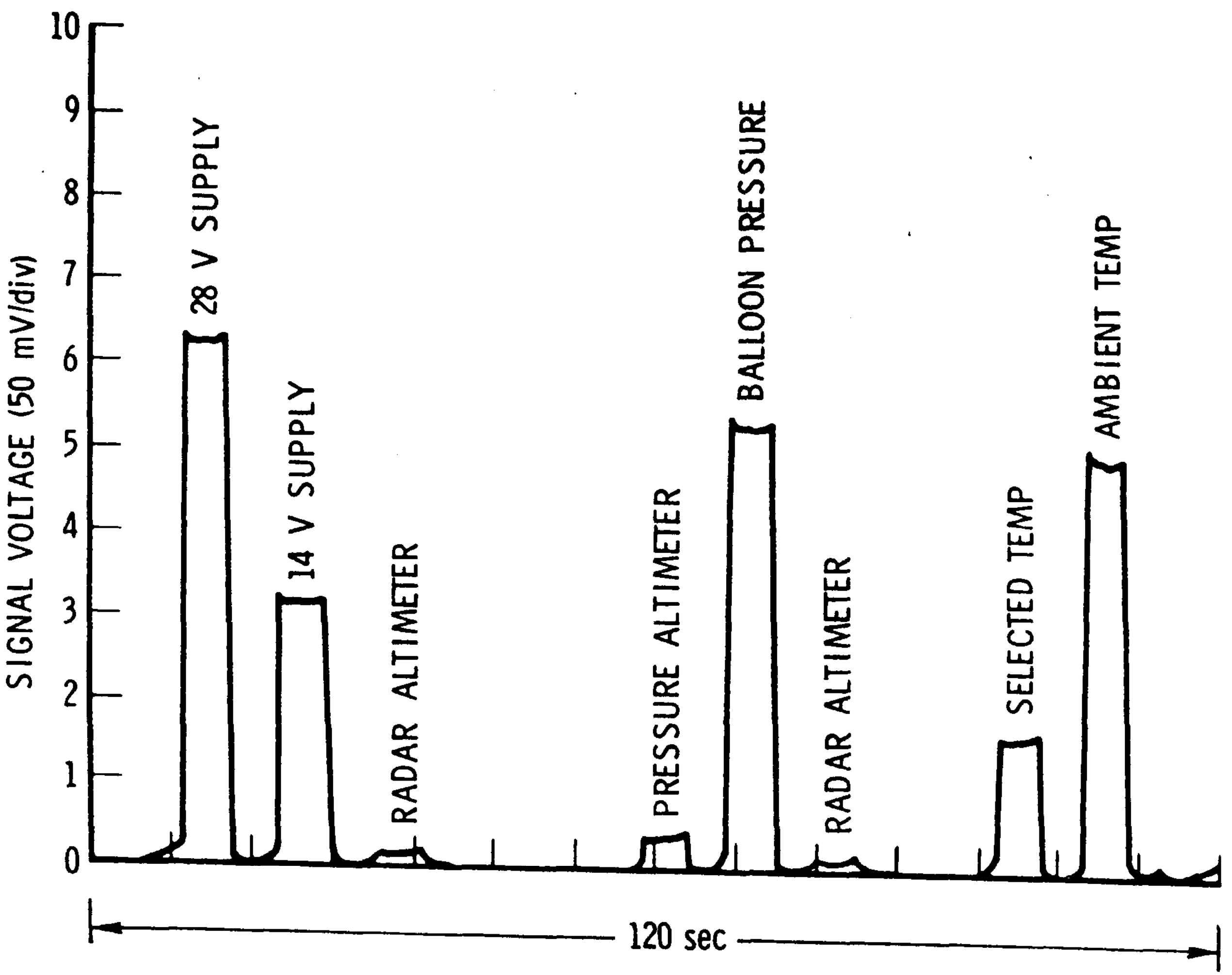


Figure 47. Commutated Data on Recorder

APPENDIX C

SYNOPSIS OF ATMOSAT-7 FLIGHT TAPE RECORDINGS

TAPE ONE - SIDE A

0841* - October 10 running countdown and testing of onboard equipment, discussion on the handling of rigging lines and ship handling.

0852* - Barograph turned on.

0902 - Made decision to liftoff with two crew members on board.

0907 - Pressure proof test (with Mike Neushul on board).

0909 - Intermediate pressure alarm sounds, pressure run to 40 mb.

0914 - Helium supply line disconnected.

0919 - Attachment of air blowers tested, tow line is on the cutter.

0925* - Blakeman indicates that sand is starting to cover the tow line, tape stopped and reversed.

TAPE ONE - SIDE B

0926* - Departure of Dr. Leverton and Dave Blakeman from balloon site to cutter, start offloading sand bags to achieve initial balance, balloon calls cutter on UHF and reports status.

0929 - Communications checks between cutter and balloon control on UHF.

0930 - Four ground personnel assigned to gondola corners, flight crew instructs them on launch procedure.

0931 - "Hands on - Hands off" tests, removal of sand bags.

0932 - Tow line to cutter becoming less slack.

0933 - All flight sand bags moved inside gondola, cutter reports to balloon that last passengers are now boarding.

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*Times indicated by asterik are time hacks on tape, other times are interpolated.

0934 - Configuration ready for launch, one floatable guide rope stretched out on the beach, tow rope connected between gondola and cutter, all systems checked out.

0935 - Balloon reports to cutter "Ready to launch whenever you are."

0938 - Balloon lifts off, balloon asks cutter to pull on tow line, drag rope in the water, 1/2 bag of sand dropped.

0939 - Altitude very low, more sand dropped.

0940 - Initial problems with the kelp.

0941 - Configuration correct and stable.

0942* - Radar Altimeter on.

0943 - Flight crew watching oscillations carefully, cutter and escort watching kelp on lines.

0945 - Balloon advises cutter to avoid balloon overflying the ship.

0948 - Cutter advises emergence from kelp bed, balloon requests "Carry on at this speed, let's see if we can shake it loose."

0952 - Convoy stopping to allow Summer Tide (escort ship) to remove kelp from lines.

0957 - Cutter reports kelp removed from lines, asks "how much line do you want out," balloon responds "looks good as it is."

0958 - Towing resumes.

0959 - Speed is 4 knots, balloon explains to cutter that yellow line dragging behind was used for the liftoff and is not being used now.

1000 - Communications control requests changeover to duplex, bag count shows 6 bags of sand on board.

1001 - Speed is 6 knots.

1002 - Chase one to balloon communications test (excellent).

1003 - Balloon control to balloon communications test (received poorly by balloon).

1003 - Balloon communication to cutter "slow it down, slow it down, slow it down, stop" (SPLASH - gondola lightly hits the water) "OK pick it up again, please what was the wind speed on that - over." cutter indicates "about 10 knots," balloon requests cutter to stop. balloon control center asked to stay off of UHF link.

1004 - Balloon crew reviews rigging status, asks cutter to put out more tow line, requests wind speed updates, 5 bags of sand onboard, wind speed is 6 knots.

1008 - Towing speed is 6 to 7 knots.

1009 - Superpressure is 34 mb, twisting oscillations on gondola. yellow dragging line dropped, cutter accelerating from 6 to 8 knots.

1012 - End of the tape.

TAPE TWO - SIDE A

1057* - System has stopped in order to winch the balloon down to the cutter, off-load a crew member, and add 4 sand bags and a second floating guide rope. This to allow flight at more than 10 knots air speed, with guide rope entirely in the air. Superpressure is 33 mb.

1058 - Art Davidson (SCAQMD) on the cutter indicates that an additional ten miles is needed to reach the launch point.

1100 - Winching not yet started, balloon standing by. Balloon crew analyses stability problem, estimates that with a sufficiently long guide rope 10 to 12 knots towing speed is achievable with 2 crew members.

1101 - Balloon requests 100 ft of line between first and second drag rope.

1102 - Balloon requests that escort vessel be used to pick up the end of the floating guide rope and deliver it to the cutter, which will add the 100 foot line and the 50 foot floating guide rope.

1104 - Crew continues the discussion of stability, Dave Blakeman (on the cutter) confirms that the cutter will haul the balloon down, and the Summer Tide will pick up the drag rope.

1107 - Descent to cutter continues, balloon crew photographs the cutter.

1109 - Balloon crew prepares light line to haul up sand bags.

1111 - Sound of helicopter flying around the balloon. Balloon crew discusses sand bag hoisting plan with cutter, sound of loud hailer on cutter issuing instructions.

1113 - Summer Tide transfers line to cutter.

1114 - Balloon crew requests the cutter to stop the descent of the balloon, balloon crew concentrates on sand bag hoisting method.

1115 - Balloon pilot decides to terminate attempt to land on the cutter, and orders slow ascent by letting out of tow line from cutter. The rotations were too excessive to allow a landing on the ship.

1119 - Balloon attempts to contact helicopter on aeronautical VHF without success.

1120 - Cutter has 600 ft of tow line out, will add 200 ft then resume tow. Balloon crew watches porpoise school.

1122 - Helicopter so close it drowns out the onboard conversation.

1123 - Crew reviews configuration, drops one bag of sand, requests wind speed (cutter reports 11 knots). Crew drops another bag of sand (part of the sand dropped into the wind and returns to the balloon).

1127 - Helicopter gone. Wind speed is 12 knots, water speed is 6 knots.

1128 - Two hundred more feet of line being let out by cutter (to 1000 ft). Two bags of sand on board.

1129 - Balloon stable and sufficiently weighted to avoid flying away in case of tow release.

1130 - Escort reports 10 ft of second guide rope section is out of the water. Balloon crew watching the seals swimming by.

1131 - Cutter reports the desired length of tow line is out.

1134 - Balloon reports sudden gusts that force the balloon downward, suggest that 14 to 15 knots appears to be present maximum acceptable wind.

1135 - Balloon calls Davidson on the cutter and reviews the option of flying with the end of the second guide rope in the water. Pilot suggests that error due to drag would be small. Davidson agrees. Decision was made to configure the balloon that way for initial hours of free flight. Davidson reports winds of Southeast 5 knots Goleta, Pt. Arguello north 5 knots.

1137 - Discussion between Heinsheimer and Davidson of wind patterns and flight plans.

1138 - Big downward oscillation.

1140 - Altimeter alarms due to oscillations.

1143 - Cutter (Davidson) estimates 7.5 miles and 2 hours to launch point.

1146 - Tape ends.

TAPE TWO - SIDE B

0850* - October 11 twenty three hours in the air. Pilot dictates a review of technical failures as follows: Marine radio working well but channel indicator lights do not work. Radar altimeter gauge is not working but recording of altimeter works well. Carabiners holding the gondola to the load ring may not be wrench tight, have been safetied with cord. Flying under a 700 ft stratus deck with the balloon slightly depressurized. Air fans not used. Small bird tried to sit on balloon rigging, is now probably on top of the balloon. Dead calm conditions, guide rope curled in the water, bits of paper fall straight down. Heard porpoise chirping in the morning before dawn. Marine radio running on its own 14 volt battery to prevent interference. Used red strobe with its integral lithium battery all night. Tape off at 0854.*

0933* - Radar altimeter not drawing power. Tape off at 0933.*

0940* - Found altimeter was not properly plugged in, corrected problem to allow recording of altitude data.

0941 - Radio station KNX report of flight including tape from balloon of pilot (Heinsheimer) describing the flight, predicting landing between 3 and 4 o'clock in the afternoon. This was followed by a report of the transatlantic balloon flight. Tape off at 0944.*

1206* - Live broadcast to KMET on the marine radio discussing the trajectory and balloon status, including the bird flying around the rigging eating moths.

1211* - Superpressure is 4 mb. Tape off at 1211.*

- KMPC broadcast about balloon spiders (time was not indicated). End of tape two side B.

TAPE THREE - SIDE A

1549* - Cutter (Davidson) predicts landing on the southern end of Oxnard Shores.

1550 - Communications between the cutter and Chase one indicating the expected landing site. Balloon crew taking pictures.

1551 - Balloon crew suggests cutter slaken line to evaluate the effect of the long drag rope (4 floatable guide ropes plus long run of nylon tow line).

1552 - Reloading camera, stowing all gear and data in waterproof bags wherever possible. Crew describing view of the beach and principal obstacles - stacks of the power station.

1555 - Cutter estimates speed at 5 knots before tying on (with 3 floating guide ropes attached to the balloon).

1558 - Chase one does not have balloon in sight, balloon reports "one-half mile south of tanks, going straight in." Chase one too far south, will move northward.

1600 - One-half millibar in the balloon, will dump residual pressure before opening the valve. Cars are in sight from the balloon.

1601 - Chase one has balloon in sight.

1602 - Cutter can approach to within 400 yd of the beach.

1603 - Plan made to have cutter approach as close as possible to shore, then play out the line to bring the balloon to the beach. Speed is at 4.7 knots, 20 minutes to go.

1605 - Balloon is very stable, pressure altitude reads 250 ft.

1606 - Crew discusses landing methods - whether to fly in high (200 to 250 ft) or low (10 to 20 ft).

1607 - Crew don helmets.

1609 - Chase one truck stuck in the sand.

1613 - Cutter's range to shore is 1570 yd (balloon is 100 yd closer). Crew observes inhospitable rocky landing area ahead; clear, sandy area about 1/2 mile to the south. Balloon requests a range "hack" every 100 yd.

1615 - 1360 yd to shore. Manual pressurization valve opened. Crew planning to land to the south of present aiming point.

1616 - Chase one is moving four men on foot with sand bags.

1617 - Balloon instructs chase to abandon sand bags. Balloon is 1100 yd from the beach.

1618 - Cutter starts towing slightly north to avoid rocky area, balloon instructs the cutter to tow southward instead. Chase one just north of rocky area.

1619 - Balloon is 900 yd from the beach. Balloon pinpoints planned landing position, transmits planned site to cutter.

1620 - Cutter towing southward, 700 yd to the beach, balloon is stable.

1624 - Balloon is 500 yd from the shoreline.

1625 - Entire line is dragging "sideways" through the water, effectively killing the beachward component.

1626 - Moving parallel to the beach, balloon pinpoints desired landing site to the cutter, 400 yd to the beach.

1627 - Chase one moving south with the balloon.

1628 - Balloon is 320 yd from the shore, two drag ropes out of the water. The sound of a helicopter moving south along the shore line.

1630 - Closed manual helium valve. Balloon is 300 yd from shore.

1631 - At lowest point, one floating guide rope and the entire 100 ft nylon line is in the air. Balloon is very stable in roll, none of the oscillations experienced in earlier towing. Ninety pound ballast margin (guide rope) and one sand bag on board.

1632 - Balloon is nearly over the surf line. "Five more oscillations" to reach the landing site.

1633 - Very stable flight, plan to allow several more oscillations southward then move on shore for landing. Balloon is 250 yd from shore.

1635 - Cutter is as close to shore as it can go. Two more oscillations, then will let more line out. Sound of cutter siren as power boat speeds southward along shoreline towards tow line, veers off in time.

1636 - Tape ends.

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